XIRIS

Inspection Solutions with Vision

OPERATORS MANUAL

OM-14002-XVC-07

Xiris WeldStudio 2 1 0 Software

Issued

Jun. 01, 2016

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1. Introduction

This manual describes the use of the Xiris WeldStudio™ software with the Xiris XVC-1000 or XVC-1000e cameras. Please also review the XVC-1000 Camera User's Manual (Xiris document number OM-14001-XVC) or the XVC-1000e Camera User's Manual (Xiris document number OM-15001-XVC) as appropriate.

WeldStudio will run on Microsoft Windows 7/8/10, in either 32 or 64 bit versions, with at least 400 MB of available hard drive capacity and at least 4 GB of RAM[1] (8 GB recommended).

For maximum performance, a four-core processor of the Intel i5 class or better is recommended. Lesser processors are acceptable, but reduced frame rate may be observed.

Efficient video display requires support for OpenGL version 3.3 or later.[2]

1.1. Symbols Used in This Manual

This user's manual uses following symbols for safety instructions and important notices:

Caution or **Warning**

Indicates a situation which, if not avoided, may result in undesired system operation or damage.

Note or **Tip**

Provides special information, references or tips about how to operating the XVC-O system more efficiently.

Stop for Important message

Stop, read and follow the important message provided before continuing the procedure or instructions.

XVC-1000e

This indicates a difference when using the XVC-1000e camera vs. the XVC-1000 camera. Note that in this manual the text "XVC-1000" refers to both camera types, unless this symbol is present to indicate otherwise.

[1] Additional RAM is recommended for multiple-camera installations.
[2] More precisely, support is required for the GL_ARB_sampler_objects extension, which is part of the OpenGL 3.3 specification. Many video cards which support only OpenGL 3.0 actually do support this specific extension. A free OpenGL extensions viewer utility from www.realtech-vr.com allows you to determine the OpenGL Extensions available on your system.

2. Installation

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Software installation is covered in the XVC-1000 Camera User's Manual (Xiris document number OM-14001-XVC) and the XVC-1000e Camera User's Manual (Xiris document number OM-15001-XVC).

3. Software Overview

3.1. Initial Startup

To start Xiris WeldStudio, double click “XirisWeldStudio” icon on the desktop.

The figure below shows the default startup configuration for WeldStudio with a single camera connected.

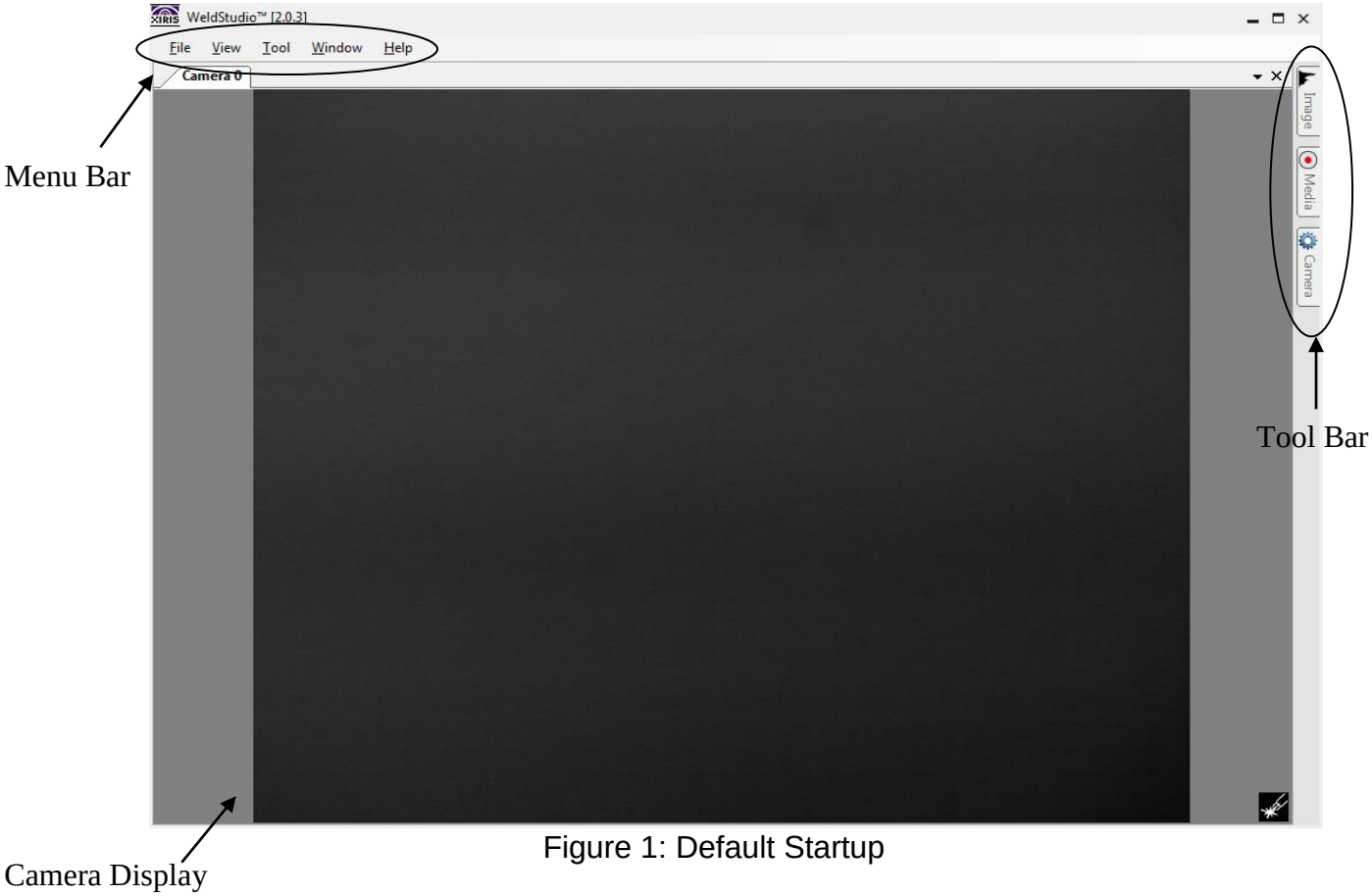


Figure 1: Default Startup

The application consists of a Menu Bar, a Tool Bar and two user-configurable Display Panels. In the default startup mode, the left-side Display Panel is visible but the right-side one is not.

The Display panels can be configured to host one or more Camera View windows, as well as one or more Tool windows. All windows can be dragged between Display panels, can be docked to the border of a Display panel, or can be un-docked to become floating windows. Additionally, the dividing line between the Display panels can be adjusted.

The state of all windows is preserved across application sessions, so that users can configure the appearance of the software to suit their applications.

In the default configuration a Camera View window for each detected camera is displayed in a tab which is docked to the center of the left panel. An Image tool window, a Camera tool window, and a Media tool are available in the tool bar located at the right side.

If there is no camera detected at initial startup, there will be no Camera View window displayed. If a camera is subsequently connected, a new Camera View window will be created automatically.

Camera View windows are preserved across application sessions.

Camera View windows can be closed by clicking the “X” at the top right corner. However, if the corresponding camera is connected in the next application session, the Camera View window will be re-created automatically.

3.2. Multiple Cameras

When more than one camera is connected, by default one Camera View window is created per camera and displayed in a tabbed format. At all times, only one camera is considered the “active” camera; the data displayed in the various Tool windows will always relate to the active camera.

You can activate a camera by:

- Clicking on the corresponding Camera View window, or
- Clicking the camera in the Connection tab of the Camera Tool window, as discussed in section 4.3.2.

3.3. Firmware Update

When connecting to a camera, a message may be shown if there is a newer firmware version available for that camera.

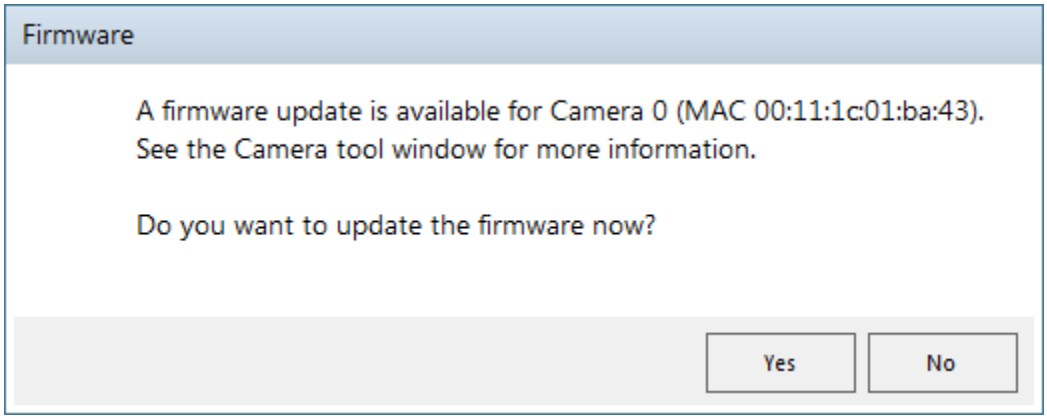


Figure 2: Available Firmware Update

Clicking **Yes** will initiate the firmware update process, which is described in more detail in Appendix B: Firmware Update. If you click **No,** you can always update the firmware later, see section 4.3.2.5. Using older firmware may mean that some functions are not optimal, but generally speaking there is no harm in using older firmware.

4. Software Reference

4.1. Manipulating Windows

All windows can be docked, undocked, etc., by dragging the window's title bar. When dragging a window, guide diamonds appear to allow you to easily re-dock the window.

4.1.1. Auto-Hide Tool Windows

Tool windows support an Auto-Hide feature. This feature allows the window to slide out of the way when you use a different window. In the default configuration, the tool windows are in the hidden state. When in the hidden state, the name of the window appears on a tab at the edge of WeldStudio, potentially overlapping part of the Camera View. To use the window, point to that tab and the window will slide back into view.

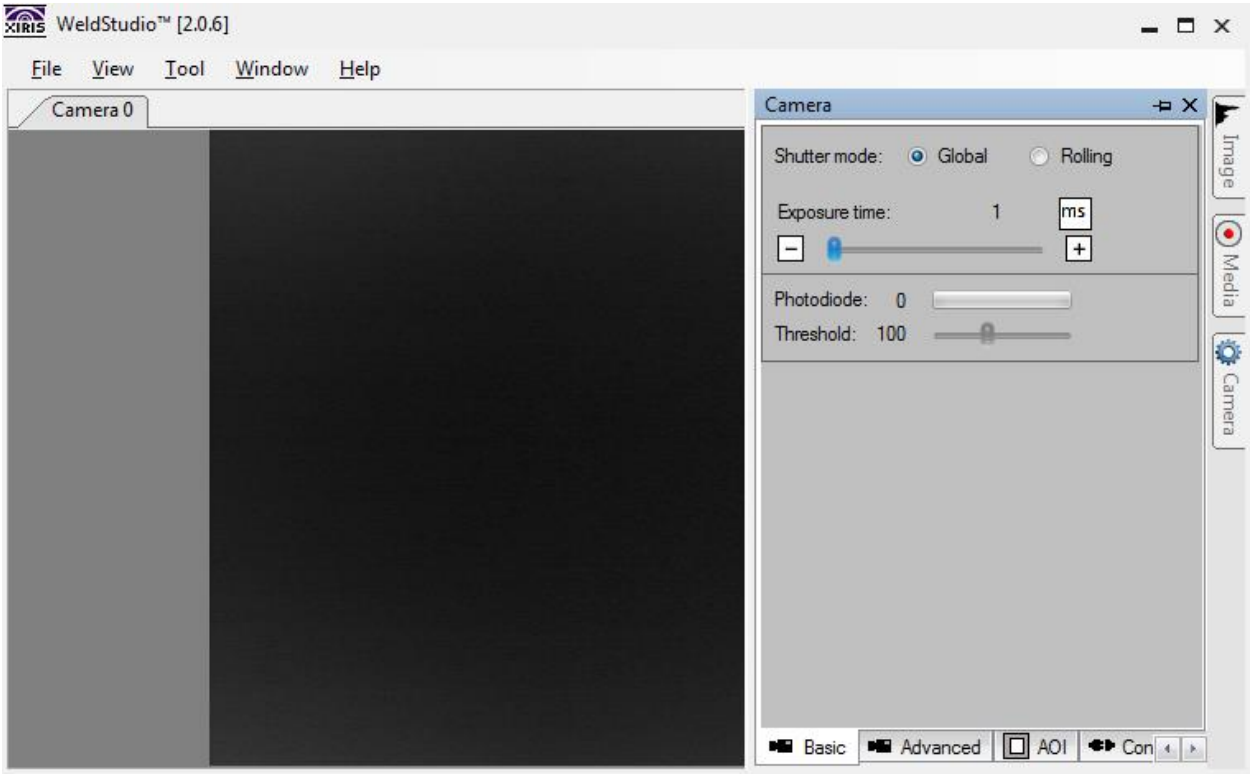


Figure 3 : Camera Tool Window Visible

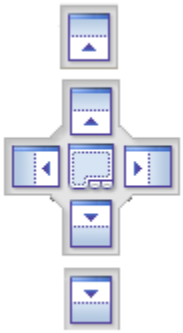
The Auto-Hide feature is controlled by the push-pin icon located in the top right corner of the tool window. When this icon is in the horizontal orientation, Auto Hide is enabled, and when it is in the vertical or "pinned" position, Auto Hide is disabled. When Auto Hide is disabled, the tool window will not overlap the Camera View window.

4.1.2. Docking Windows

Note: Tool windows with Auto Hide turned on cannot be manipulated. To dock, undock, move, etc., you must first click on the pin icon to turn off Auto Hide.

To dock windows:

1. Click the title bar area of the window you want to dock
2. Drag the window towards the middle of the WeldStudio application window. Various guide diamonds will appear, indicating potential docking positions.



3. When the window you are dragging reaches the desired docking location, move the pointer over the corresponding portion of the guide diamond. The designated area will become shaded.
4. To dock the window in the indicated position, release the mouse button.

Windows can be docked at the edges of the panels, or in the center. If multiple windows are docked the same way, they are displayed using separate tabs.

To float windows:

1. Follow the procedure above but release the mouse button while the window you are dragging is outside of any docking location

or:

2. Double-click on the window's title bar

4.1.3. Closing Tool Windows

Tool windows can be closed using the "X" icon at the top right of the window.

4.1.4. Opening Tool Windows

New tool windows can be opened by clicking on the corresponding tool window item in the **Tool** menu (Figure 4), or by clicking the corresponding icon in the toolbar.

Figure 4: Window Drop Down

4.1.5. Re-sizing Tool Windows

Tool windows can be resized by dragging their borders. Note, however, that the aesthetics of resized tool windows may be undesirable.

4.1.6. Camera View Windows

Camera View windows behave in a similar manner to Tool Windows, they can be docked or floated, but do not have Auto-Hide capability.

One significant difference is that if a Camera View window is closed, it can only be re-opened from the Connections tab of the Camera Tool window. See section 4.3.2.1 below for more information.

When resized, Camera View windows will automatically adjust the image display area to maintain the correct image aspect ratio.

4.2. Menu Reference

4.2.1. File Menu

Exit	Exits WeldStudio to Windows

4.2.2. View Menu

Tool Bar	Toggles display of the toolbar.
Status Bar	Toggles display of the status bar (at the bottom of the main window).

4.2.3. Tool Menu

Image	Opens the Image Tool window.
Media	Opens the Media Tool window
Camera	Opens the Camera Tool window
Measure	Opens the Measure Tool window
Focus	Opens the Focus Tool window
Blob Analysis	Opens the Blob Analysis Tool window
Edge Detector	Opens the Edge Detector Tool window
Light Meter	Opens the Light Meter Tool window
Digital I/O	Opens the Digital I/O tool window
Lock Windows	When this item is checked, the user cannot move any windows, or close tool windows.
Create Virtual Camera	Creates a new virtual camera and a corresponding Camera View window. See section 5 for more information.
Preferences	Activates the Preferences window, where the user can control various optional aspects of WeldStudio. See section 4.3.5 for more information.
Add-Ins	Allows configuration of various optional add-in software packages. See section 8 for more information. This menu item will be disabled if no add-ins are installed.

4.2.4. Window Menu

Displays a listing of current Camera View windows.

4.2.5. Help Menu

About…	Displays information about WeldStudio.
Connection Diagnostics	Opens the Connection Diagnostics window,

	which is used to view messages from the camera detection software. See section 4.4 below

4.3. Window Reference

4.3.1. Camera View

A **Camera View** window is used to display the video from the camera, display information about the camera, and provides access to common control functions.

Note that several of the status information items shown below are not visible by default and must be explicitly enabled as described further below.

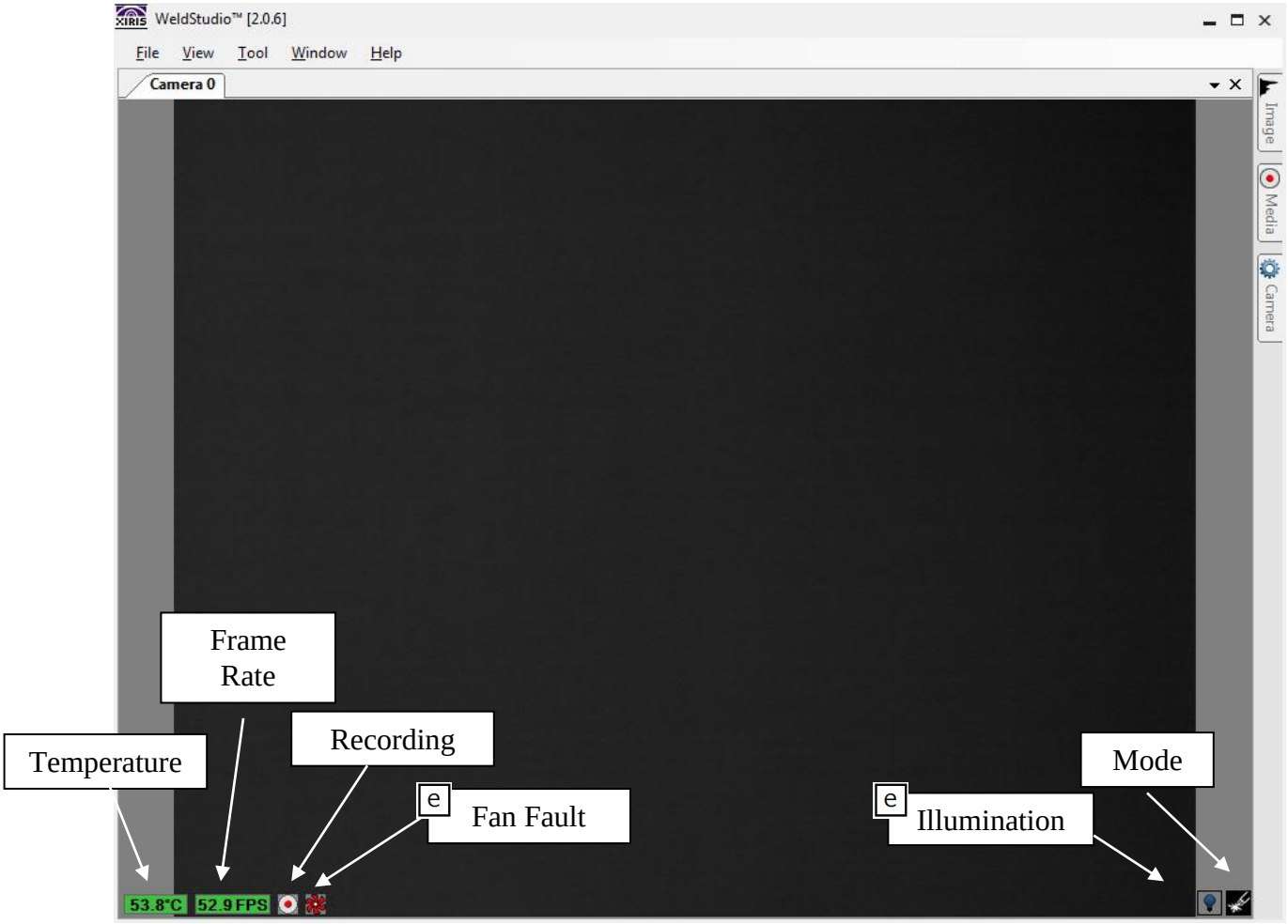


Figure 5 : Camera View Window

Temperature (normally hidden)	Displays the current internal temperature of the camera. By default this is in degrees Celsius, but Fahrenheit degrees can be selected via the **Preferences** window. In general the temperature should not be allowed to exceed 60˚C, and in no case should it be allowed to exceed 70˚C. Above 60˚C, the background of the display will switch from green to yellow, and will go red if 70˚C is exceeded. Consult the camera manual for more information about cooling options.
Frame Rate (normally hidden)	Displays the average frame rate. This is the rate at which the software is processing images. This is impacted by: • When the camera is in Global Shutter mode, the Exposure Time; when the camera is in Rolling Shutter mode the Frame Rate setting • The processing power of your computer (clock frequency, number of cores, etc.) • The number of image processing operations being performed. • The configuration of your network adapter (see the camera manual for optimal settings). The frame rate calculation is restarted when you change the camera settings Shutter Mode, Frame Rate, Exposure Time. The color of this display indicates how much processing time is being used to generate the displayed video, as a percentage of the achieved frame rate. Below 50% use, the display will be green, above 80% use it will become yellow and become a brighter yellow as 100% is approached.
Recording	This indicator will flash whenever WeldStudio is recording video and/or raw images.
Fan Fault e	When WeldStudio is used with an XVC-1000e camera, this indicator will flash if a fault is detected with the camera's air circulation fan. Depending on the ambient conditions, operation of the XVC-1000e camera without an operable fan may result in damage to the camera.
Illumination e	Turns the on-board lighting system of the XVC-1000e camera on or off. The intensity of the lighting can additionally be controlled from the **Camera** tool window.

Mode	The software operates in one of two modes, Welding and Setup. Select the operational mode by clicking on this icon.  Setup mode  Welding mode Certain settings can be assigned one value to be used in Setup mode and a different value to be used in Welding mode. These settings are indicated by the presence of the  icon in their descriptions throughout this document. Note: the mode can also be controlled via the “Trigger 2” input of the camera.

Display of the Temperature and Frame Rate is controlled from the **Preferences** window; see section 4.3.5 for more information.

Additional diagnostic information about the connected camera can be accessed by right-clicking on the Camera window to access the pop-up menu, and selecting **Properties** (Figure 6).

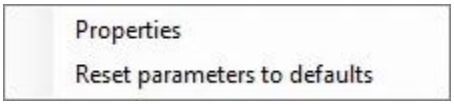


Figure 6: Right Click Pop up Menu

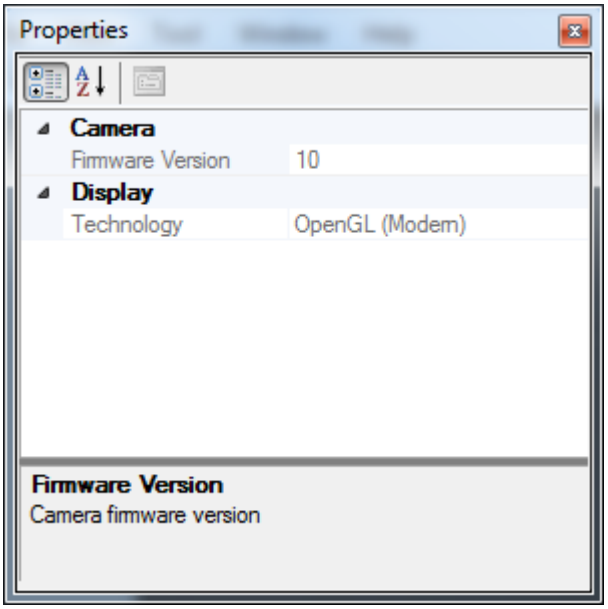


Figure 7: Camera Window Properties

4.3.2. Camera Tool

The **Camera Tool** window contains four tabs: **Basic**, **Advanced**, **AOI**, and **Connection**, as shown below.

4.3.2.1. Basic

The **Basic** tab allows control and read-back of the following more commonly changed camera settings / observed values.

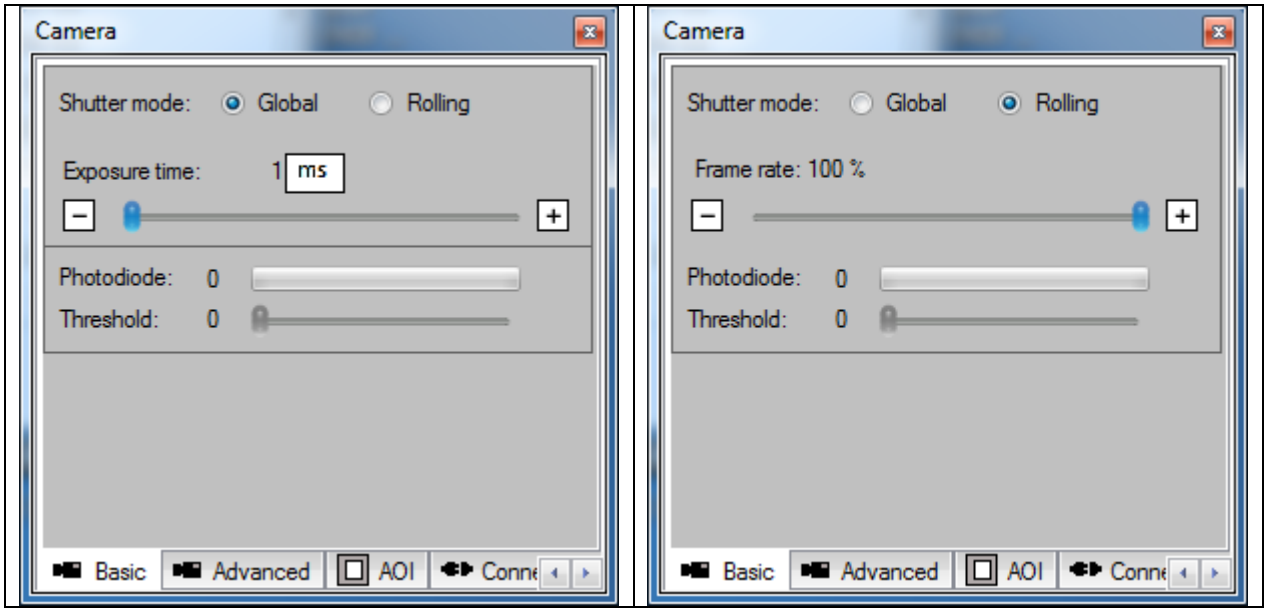


Figure 8 : Camera Tab (Global and Rolling Shutter)

Shutter mode 	This can be **Rolling** or **Global**. See below for more details.
Frame Rate (Rolling Shutter) 	When in **Rolling** mode, the frame rate can be adjusted, up to a maximum of 55 frames per second at full resolution. To a certain extent, using a slower frame rate can allow the sensor to capture more light in low-light conditions.
Exposure Time (Global Shutter) 	When in **Global** mode, the exposure time can be adjusted, in either milliseconds or microseconds. Depending on the amount of light available, using a longer exposure time can generate higher-contrast

	images in low-light conditions, at the expense of a slower frame rate. Note that because the frame is first exposed and then read out, the expected frame rate will not be the reciprocal of the exposure time. At full resolution, in 12 bit mode, the GigE transfer overhead is at least 16 milliseconds. Additional smaller overheads exist as well. For example, at 30 ms exposure time we would expect a frame rate of not more than 1 / (0.030 + 0.017) = 21.3 frames per second.
Photodiode	The XVC-1000 camera contains a photodiode which can provide an indication of the amount of light reflecting onto the camera. When WeldStudio is configured to use Auto weld mode, the photodiode value is used to automatically switch between Welding and Setup modes. It should be noted that the value is reported from the camera as meta-data associated with each image. Thus, it is updated only when a new image is received, which is important to realize when using a triggered acquisition mode.
Threshold	When Auto weld mode is enabled, this sets the Photodiode level above which WeldStudio will select Weld mode. Below this level WeldStudio will automatically select Setup mode.

Shutter Mode

In **Rolling** shutter mode, each video line is read out while the other lines are being exposed. This allows for more sensitivity in low-light conditions, but with predictable distortions of fast-moving objects or rapid light flashes (common in pulsed welding) because the exposure of each line is slightly offset in time with respect to its neighbor.

In contrast, **Global** shutter mode exposes all lines at the same time, and then reads them out, avoiding the rolling shutter motion/flash artifacts.

Pixel Depth

Internally, the XVC-1000 camera generates data with 12 bits of intensity information per pixel[3]. The camera can be configured, via the **Pixel Depth** setting, to either transmit this data directly, or to compress the data to 8 bits per pixel based on the intensity range observed in the previous frame.

When set to **12 bits**, the WeldStudio software must convert the data to 8 bits per pixel to allow it to be displayed. This can be done in a more sophisticated algorithm than the on-camera algorithm, resulting in a displayed image with reduced instances of digital saturation. The disadvantages of this approach are increased CPU load, and a 50% increase in network traffic vs. 8 bit mode.

Firmware Update

The firmware update indicator reflects the availability of new firmware for the camera. If newer firmware is available, the message text will be shown in red.

Clicking on the message will show a window from which you can start the update process and modify the notification settings. For more details see Appendix B: Firmware Update.

4.3.2.2. Advanced

The **Advanced** tab allows control and read-back of the following less commonly changed camera settings / observed values.

Note that the appearance of the tab will be slightly different when used with an XVC-1000e camera vs. an XVC-1000 camera.

[3] Due to the nature of the camera's electronics, the available pixel values are actually in the range of ~2040 to 4095, so technically one could consider it an 11-bit value.

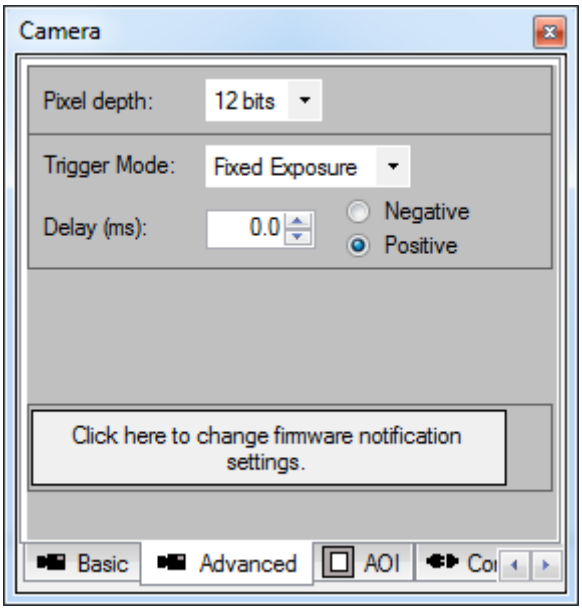


Figure 9 : Advanced Tab, XVC-1000

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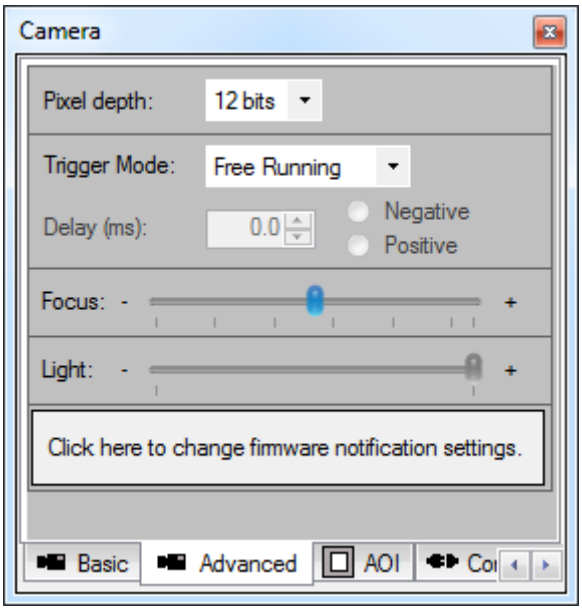


Figure 10 : Advanced Tab, XVC-1000e

Pixel Depth	The XVC-1000 camera can operate in either 12 bit or 8 bit mode. The advantages and disadvantages of each mode are explained below.
Trigger Mode 	The XVC-1000 camera can produce video in one of three modes, as detailed further in the XVC-1000 User's Manual.

	• In **Free Running** mode, the camera continuously outputs frames. This is the default mode of operation. • In **Fixed Exposure** mode, (a.k.a. Mode 1) the camera waits for a trigger input before it outputs a single frame using the current Exposure and Shutter settings. • In **Pulse Exposure** mode (a.k.a. Mode 2, available in Global Shutter mode only) the camera waits for a trigger input before outputting a single frame. The exposure time is controlled by the length of the trigger pulse.
Trigger Polarity 	The trigger event can be configured to fire upon detection of either the **Positive** or **Negative** going transition on the trigger input line.
Trigger Delay 	This controls the length of time after the transition of the trigger input line before the frame exposure starts.
Focus 	This controls the camera focus. It is only visible if an XVC-1000e camera is connected. Note: Focus control adjustments are not instantaneous. Please wait after changing this setting to allow the camera to adjust.
Light 	This controls the intensity of the camera's illumination system. It is visible only if an XVC-1000e camera is connected.

4.3.2.3. AOI

The AOI (Area of Interest) tab allows WeldStudio to use an image which is smaller than the full size available from the camera's sensor.

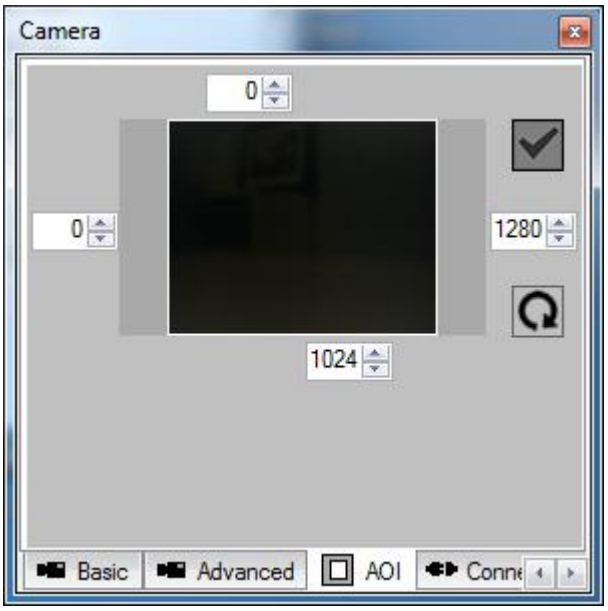


Figure 11 : AOI Tab

The XVC-1000 camera's sensor has 1280H x 1024V pixels. The camera can reduce this vertically by adjusting the **Top** and **Bottom** lines of the readout sequence. The nature of the sensor means that the horizontal readout timing cannot be modified, however WeldStudio allows cropping in the horizontal dimension by adjustment of the **Left** and **Right** values.

Changes are not applied until the  button is clicked.

Use the  button to revert to the full sensor size.

Restrictions

The values for all AOI settings must be multiples of 4. Hence the smallest vertical AOI will be 4 pixels high. If user enters a number which is not a multiple of 4, it will be rounded to a nearest number that is a multiple of 4.

Impact on Frame Rate:

Because horizontal cropping is performed by the PC, the impact on frame rate will be minimal.

Vertical cropping can, however, have a significant impact on frame rate due to the reduced amount of data transferred over the Ethernet connection.

Because of the number of different factors at play, it is not possible to analytically predict the frame rate which can be achieved for a given AOI height. One should not expect an increase in frame rate directly proportional to the AOI height change.

Specifically it should be noted that in global shutter mode, the exposure time may play a significantly larger role in determining frame rate than does AOI height.

For example, at a 30 ms exposure time on a system achieving 21 FPS at full image height, cutting the AOI to 512 pixels might result in an increase only to 26 FPS.

This can be understood based on the discussion of the Exposure Time property in the Camera tab, above. At full frame height the time for one image is approximately (0.030 + 0.017) = 0.047 seconds, i.e. a frame rate of 21.3 FPS. At half that height, the time would be approximately (0.030 + 0.0085) = 0.0385 seconds for a frame rate of 26.0 FPS.

However, consider the case of a 1 millisecond exposure time. In this case the full frame rate would be expected to be around 1 / (0.001 + 0.017) = 55.6 FPS, but at 512 lines this would be approximately 1 / (0.001 + 0.0085) = 105.3 FPS.

Note that in these examples we have assumed that halving the number of lines will halve the transfer time. It should be noted that this is not a completely valid assumption. It is approximately accurate for relatively full-height AOI's, but the rate of decrease in transfer time will slow as the AOI gets shorter.

4.3.2.4. Connection

The **Connection** tab displays information about all current and previously connected cameras.

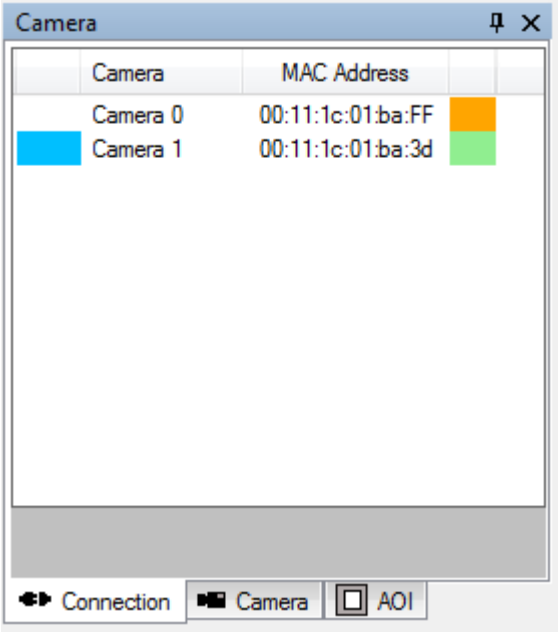


Figure 12: Connection Tab

The tab contains a grid with four columns. Each line represents a potential camera connection.

The left column highlights the camera which is currently selected.

The *Camera* column shows the name of the camera. Cameras are automatically named in order of discovery, starting at “Camera 0” and continuing.

The *MAC Address* column shows the unique identifier code for the camera.

The right-most column shows the status of the connection to the camera:

Green	Connected, with a corresponding **Camera View**
Amber	Previously connected, but not currently connected
Red	Connected, but with no corresponding **Camera View** window

A context menu can be activated by right-clicking on any camera in the Connections list.

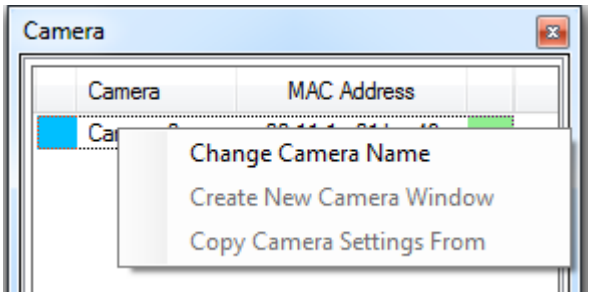


Figure 13 : Connections Context Menu

The context menu contains three items:

Change Camera Name	This allows you to change the name of the camera
Create New Camera Window	Click this item to create a Camera View window for a camera which is connected but not currently assigned to a Camera View.
Copy Camera Settings From	Click this item to transfer the settings of one connected camera to another.

4.3.2.5. Camera

4.3.3. Image Tool

An Image Tool window is used to control the image processing functions available within WeldStudio. It consists of four tabs: **Levels**, **Process**, **Cross Hairs**, and **Pseudo Color**, as shown below.

4.3.3.1. Image

The **Image** tab controls how images are processed by WeldStudio.

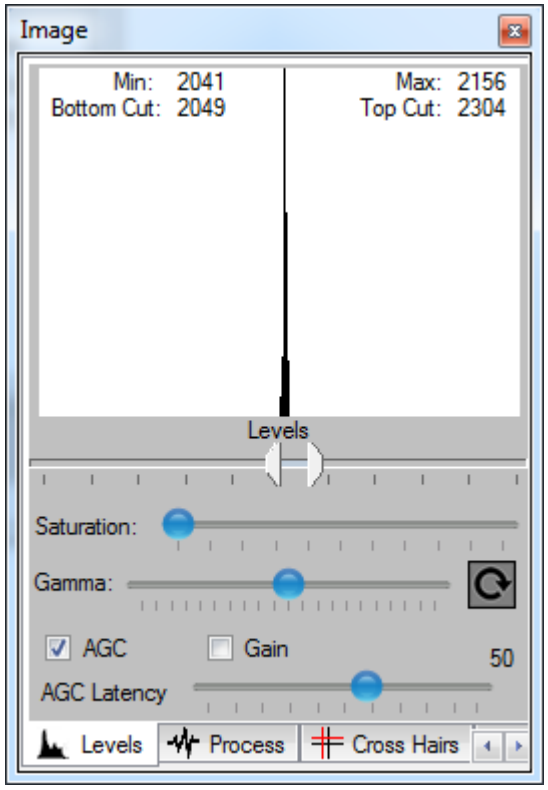


Figure 14: Levels Tab

At the top of the window is a histogram which shows the distribution of the pixel values received from the camera. Note that in 12-bit mode (shown above), the camera produces pixel values starting from approximately level 2000, so there will never be data in the left side of the distribution.

For purposes of display, WeldStudio must map the pixel values supplied by the camera to a displayable range of 0 to 255. To do this, it needs to know the value of the darkest pixel and the brightest pixel. For the information of the user, these values are displayed at the top of the histogram, in fields named **Min** and **Max**.

The following parameters can be adjusted using the controls in this window. More information is available following the table.

Bottom Cut 	Controls the digital level from the incoming image which will be mapped to black in the displayed image. When **AGC** is off, this value can be adjusted manually by moving the position of the left-hand slider located below the histogram.
Top Cut 	Controls the digital level from the incoming image which will be mapped to white in the displayed image. When **AGC** is off, this value can be adjusted manually by moving the position of the right-hand slider located below the histogram.
Saturation 	Controls the percentage of pixels which are allow to have value 255 for display purposes. Increasing the saturation level will tend to obscure the weld arc area, but allow more dynamic range for the rest of the scene.
Gamma 	Controls the process for mapping the valid input range of pixel values to the displayable range.
AGC 	When checked, WeldStudio automatically calculates the best Bottom and Top Cut values to achieve the best contrast.
Gain 	When checked, allows the AGC algorithm to implement a digital gain. Normally the AGC algorithm will not produce more output levels than input levels. When checked, the algorithm may produce 256 output levels from as few as 32 input levels.
AGC Latency 	Controls the number of images considered in the AGC calculations. Using more images will “dampen” the response to avoid undue impact of electrical noise, etc. Using fewer images, on the other hand, may allow for faster reaction to weld flash, for example.

Image Display Generation

From the **Min** and **Max** information, a “valid range” of pixel intensity values is “cut” from the input range. WeldStudio then displays the pixels at the bottom of this range as pure black, and at the top of this range a pure white, with intermediate values mapped accordingly. The so-called “cut”

range is displayed for the information of the used at the top of the histogram, in fields named **Bottom Cut** and **Top Cut**.

WeldStudio can automatically determine the **Bottom Cut** and **Top Cut** values, or they can be manually controlled by the user. When the **AGC** check box is checked, the process is automatic. When the **AGC** check box is unchecked, the user can manipulate the values by dragging the double sliders located under the histogram display area.

The calculation of the **Top Cut** point is influenced by the **Saturation** setting, as described above.

The mapping of the valid range to the output image can additionally be made non-linear by the use of the **Gamma** slider. Moving this slider to the left will cause more detail to be visible in the dark areas; moving the slider to the right will cause more detail to be visible in the bright areas.

Special consideration must be given to the situation when there are fewer than 256 levels of valid pixel data. Displaying this data over the full 256-level output range results in a digital gain condition which can create an unnatural image with excessive noise. For this reason, the AGC algorithm will normally restrict the **Top Cut** value to be no lower than 256 levels above the **Bottom Cut**. However, in the case of extremely low light entering the camera, in some cases you may want to allow a digital gain to occur. This can be allowed by checking the **Gain** check box.

4.3.3.2. Process

The **Process** tab controls the available additional image processing options.

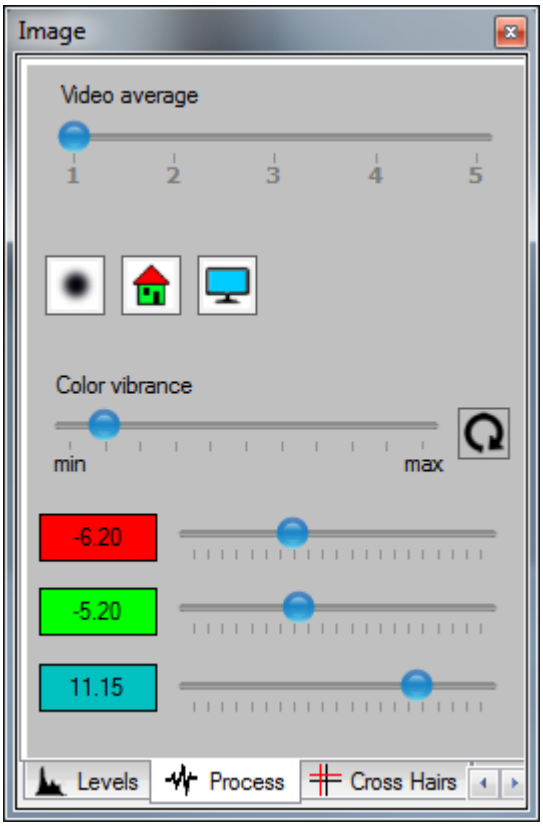
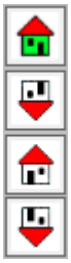


Figure 15 : Process Tab

Video Average	Selects the number of frames to be averaged, on a rolling sample basis, prior to display. Video averaging can be useful to reduce the flashing artifacts associated with pulsed welding. Note that the
 Sharpening	When activated, Sharpening will cause increased emphasis of edges in the image, at the expense of increased noise.

 Image Flip	The image can be flipped into various orientations to compensate for the installation position of the camera. Repeated clicks on this icon cycle through the following orientations (as shown at left): 1. Home (green icon) 2. Vertical flip 3. Horizontal flip 4. Vertical and Horizontal flip
 Display Rotation	The image can be displayed with a rotation of 0°, 90° or 270°. There is no 180° option because this can be accomplished through a combined vertical/horizontal flip, see above. Repeated clicks on this icon cycle thorough the possible options, as shown at left.
Color vibrance	This algorithm is designed to provide more vibrant colors while attempting to maintain realistic color balance. Adjust the level to suit your personal preference. Click on the “Reset” button to return to the factory default value. This item is obviously not available for monochrome cameras.
Manual RGB	These three sliders let you adjust the scaling factors applied to each of the color channels, providing you with manual control of the color white point. Click on the channel value to reset that channel to the factory default value.

Note that most processing operations have an associated CPU load increase. Depending on your PC’s CPU, you may observe a reduction in frame rate when processing operations are used.

4.3.3.3. Cross Hairs

The **Cross Hairs** tab allows you to control the generation of cross hairs and a central target to be displayed over the image.

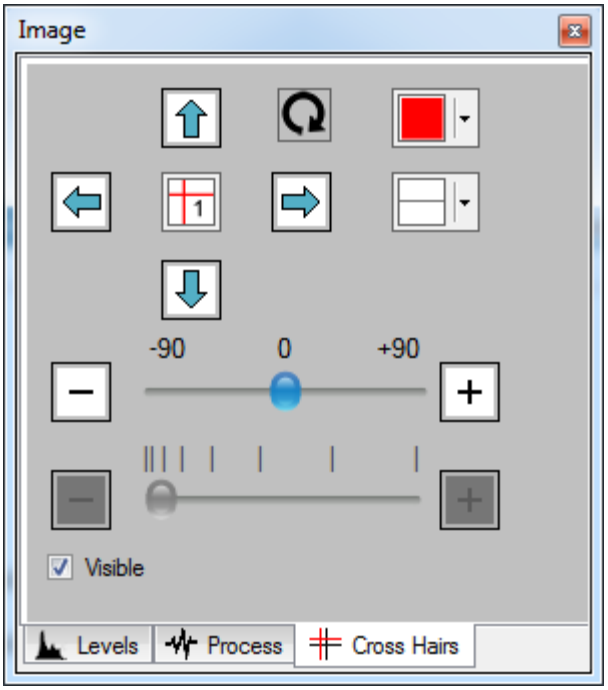
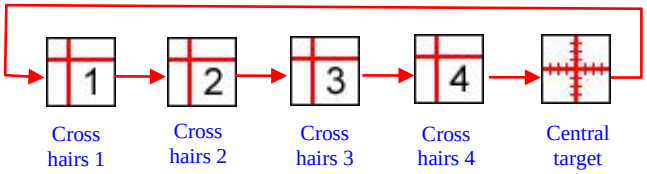
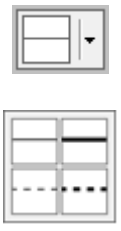


Figure 16 : Cross Hairs Tab

	Selects the cross hair to be manipulated. To navigate to other cross hairs, and then to the target, continue clicking through the cycle:  Cross hairs 1 → Cross hairs 2 → Cross hairs 3 → Cross hairs 4 → Central target
	Activates the color selection selector, which allows you to select the color for the active cross hair / target. To disable the cross hair / target, select the  button.
	Activates the line style selector, which allows you to choose the line style for the active cross hair. (Not applicable to the center target.)

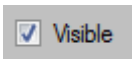
	Use the arrow buttons to manipulate the position of the selected cross hair (not applicable to the center target).
	Rotates all active crosshairs.
	Changes the spacing of the scale markers on the center target.
	Moves each cross hair back to its default position at the middle of the image.
	Un-checking this master control will suspend display of all cross hairs and targets.

Figure 17 shows an example configuration with one cross hair, rotated, and the center target.

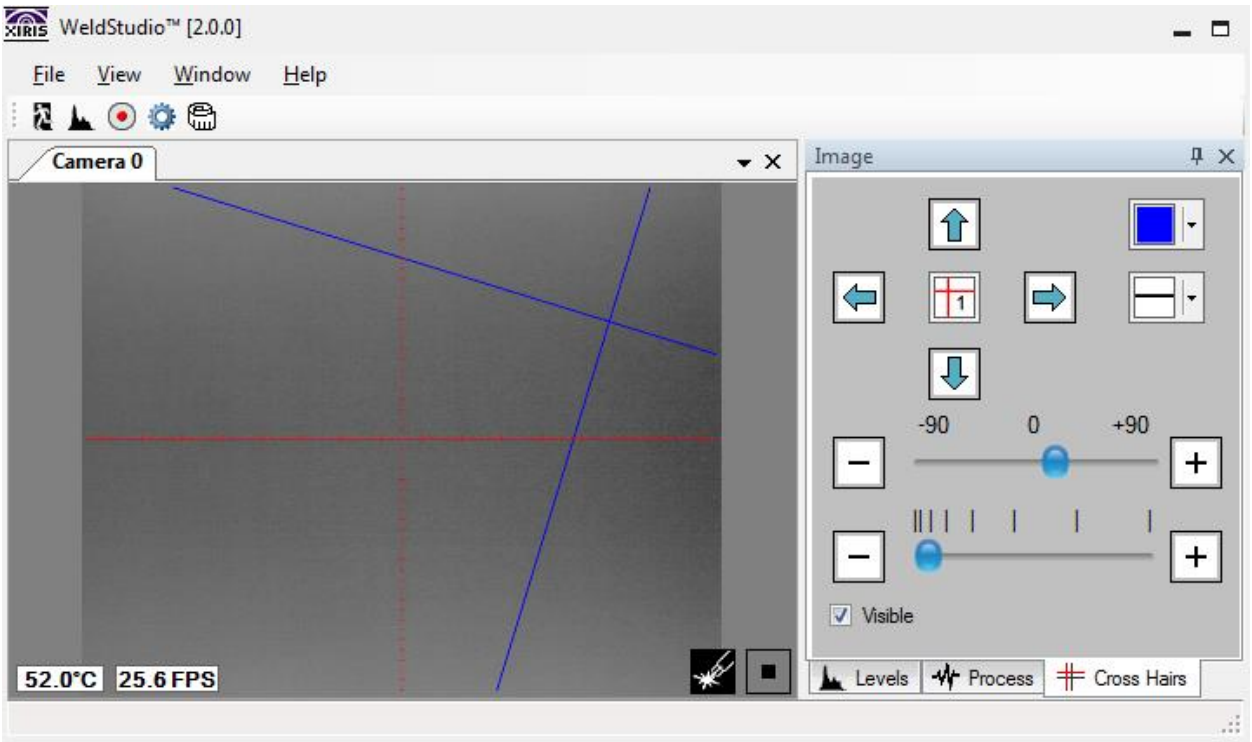


Figure 17 : Sample Overlay

When the **Cross Hairs** tab is selected, the position of the selected cross hair can also be modified using the mouse.

- Move the mouse pointer over the image to the desired location of the center of the cross hair.

- Press the left mouse button; the cross hair will move to the indicated position.
- While the left mouse button is held down the cross hair will move with the mouse pointed.
- Release the mouse button when the cross hair is in the desired position.

4.3.3.4. Pseudo Color

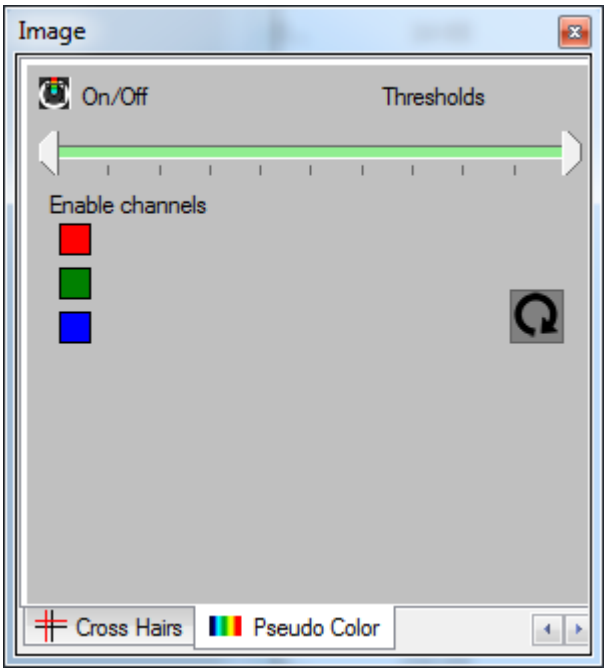


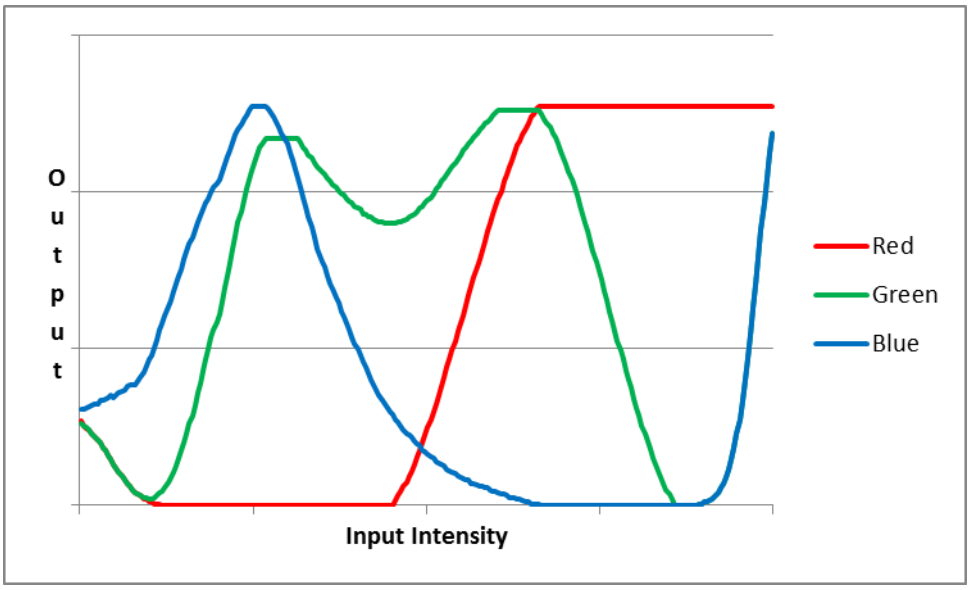
Figure 18 - Pseudo Color

The image will be mapped from monochrome (for color cameras, the intensity value (r+g+b)/3 is used) to pseudo color.

The output can be controlled so that the pseudo-color algorithm generates a range which includes any or all of the RGB channels, and that range is applied over any range of input pixel intensities.

The palette used is a typical thermal palette as shown below.

This is constructed using R, G, and B values as seen in the chart below.



The pseudo-color image is generated by applying the selected components of the palette, in the range specified by the **Thresholds** slider. Pixel values outside of the specified range will be shown in their standard representation.

4.3.4. Media Tool

The **Media Tool** window contains controls which allow you to record the video and images in several different formats.

- The video stream, including the graphical overlay[4], can be recorded to an AVI video file.
- Raw images (the un-manipulated 8- or 12-bit pixel data) can be recorded. One file is created for each image from the camera; as you might suppose this can generate a large amount of data. These images are saved exactly as received from the camera, prior to any selected processing or graphical overlay operations.
- Single snapshots of the currently displayed image can be created on demand. These are saved in the standard Windows PNG format. Snapshots are saved without the graphical overlay, but with image flip applied.

[4] Cross hairs, targets, etc.

Windows operating systems require a certain amount of free space on the **C:** drive to operate effectively.

Therefore, careful consideration should be given to the selection of a Recording folder, particularly if many files will be recorded.

To avoid any possibility of filling the **C:** drive, consider recording to a different logical partition.

4.3.4.1. Videos

The Videos tab allows control of video recording for the currently selected camera.

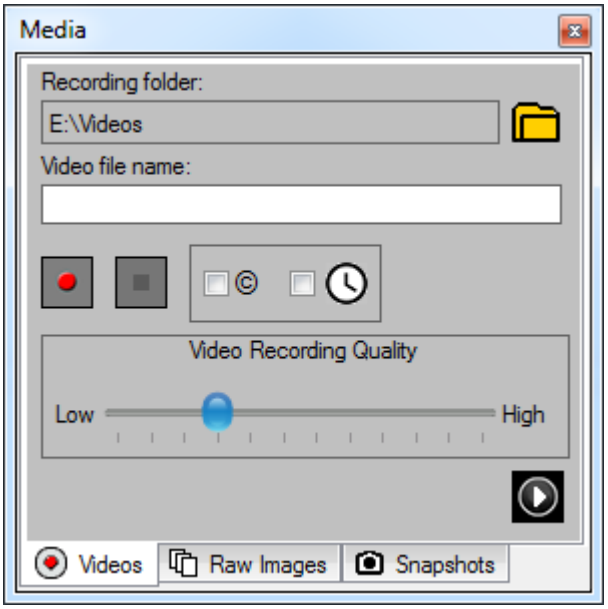


Figure 19: Videos Tab

To prepare for recording a video, you must first consider the destination folder for the recording. By default, this will be **C:\Xiris Data\XirisWeldStudio\Videos**.

To change the Recording folder, click on the folder icon . This will open a standard Windows folder browser dialog. Select your destination folder and click OK.

As is the case in most Windows browsers, you can right-click to access a pop-up menu from which you can create a new folder.

Recording videos directly to a USB drive may result in dropped video frames if the bandwidth of the USB connection is insufficient. The more robust way is to save the recording to the internal drive first, then copy the file to an external device as required.

WeldStudio will automatically create a file name for the video file. This will take the format of *yymmdd-hhmmss-name*.avi, where:

- *yymmdd-hhmmss* represents the year, month, day, hour, minute, second when the recording started, based on the PC clock.
- *name* can be specified in the **Video File Name** field. If no name is specified, then the camera's name will be used (e.g. Camera 0).

In order to ensure that all video names are unique, WeldStudio will not record a video shorter than one second long.

The quality of the recording process can be controlled using the **Video Recording Quality** slider. Moving this slider to the left will cause the recorded video file to be smaller, but with more compression artifacts. Moving the slider to the right will cause fewer compression artifacts, but the resulting video file will be larger.

Click this button to start recording.

Click this button to stop recording.

Alternatively, recording can be controlled using the camera's general purpose digital I/O input # 1, or via the Auto recording feature[5] which will start recording when WeldStudio changes from Setup to Weld mode.

Check this box to record a copyright message in the bottom left corner of the video. The name of the copyright owner can be changed in the **Preferences** dialog.

Check this box the record timing information in the top left corner of the video. The type of timing information can be controlled via the **Preferences** dialog.

Recorded videos can be played using most available players.

[5] See the **Preferences** dialog, section 4.3.5

For your convenience, WeldStudio includes the Xiris' proprietary XVideoPlayer, which can be accessed by clicking this button.

The player will automatically open the last-recorded video.

More information about XVideoPlayer is available in Section 7 below.

4.3.4.2. Raw Images

The **Raw Images** tab controls the saving of raw images.

Raw image files are *huge*! Recording sessions should typically be limited to a short duration, and hard drive capacity must be considered and monitored.

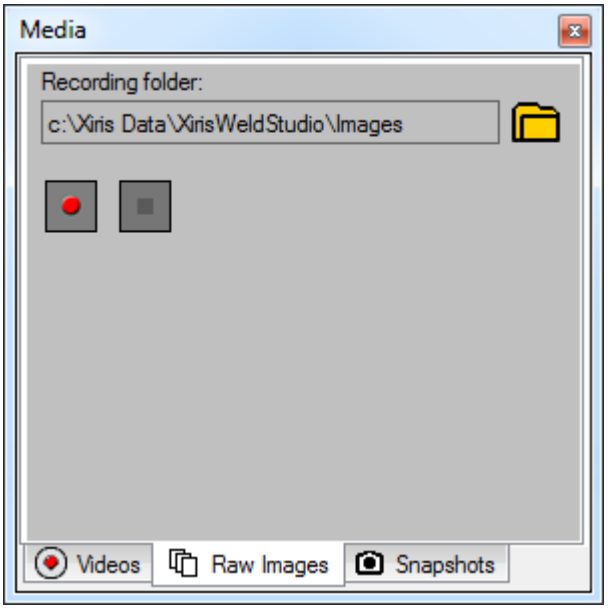


Figure 20 : Raw Images Tab

To change the Recording folder, click on the folder icon  . This will open a standard Windows folder browser dialog. Select your destination folder and click OK.

Images are saved in sub-folders beneath the selected folder, each being named in the format of Images-*yymmdd-hhmmss*, where:

- *yymmdd-hhmmss* represents the year, month, day, hour, minute, second when the recording started, based on the PC clock.

Each image is saved in a file named Image*xxxxxxx*.dat, where *xxxxxx* represents a sequence number, i.e. 000001, 000002, etc.

Click this button to start recording.

Click this button to stop recording.

Alternatively, raw image recording can be controlled using the camera's general purpose digital I/O input # 2.

On most systems, you will see a reduction in frame rate when recording raw images. This is due to the amount of data being transferred, and is expected. After the recording is complete, it may take some time for the displayed frame rate to recalculate. You can force a recalculation by double-clicking on the frame rate display.

The format of the raw image file is described in Appendix A.

4.3.4.3. Snapshots

The **Snapshots** folder allows you to record snapshots on-demand, which can be useful for documenting a particular event.

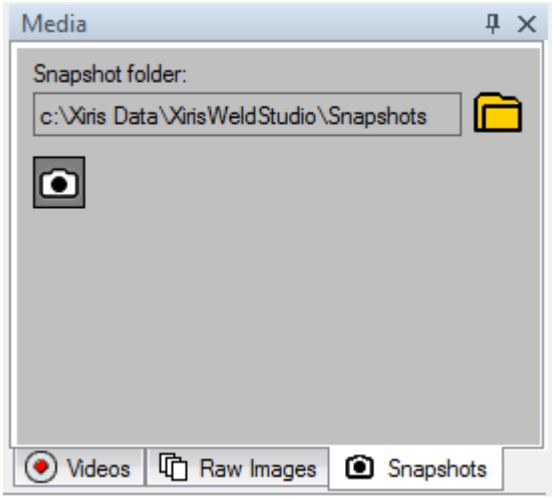


Figure 21 : Snapshots Tab

Click on the Camera icon to generate a snapshot. Snapshots are saved in the specified folder (see instructions for videos or raw images), with the file named *name-yymmdd-hhmmss*.png, where *name*, and the timestamp information, are the same as described above for videos.

4.3.5. Preferences

The **Preferences** dialog is accessed by clicking the **Tool → Preferences** menu item.

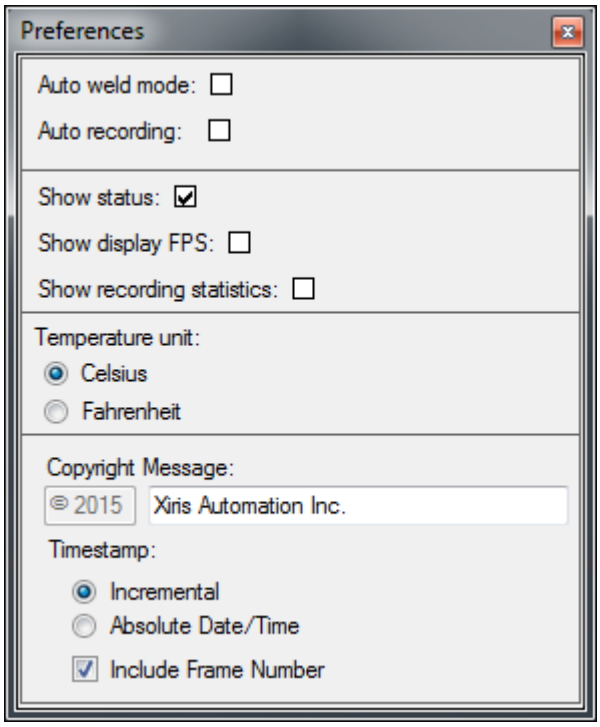


Figure 22: Preferences

Automatic Functions	
Auto weld mode	When this mode is active (checked), WeldStudio will automatically switch between Setup mode and Weld mode, as described in section 4.3.2.1.
Auto recording	When this mode is active (checked), WeldStudio will automatically start recording when the system changes from Setup mode to Weld mode, and stop recording on the opposite transition. Note that the cause of the mode change (which could be via Auto weld mode, via the user changing the mode manually, via digital input, etc.) is not important here, so recording could be started by one mechanism and stopped by another.
Display Configuration	
Show status	When checked, the temperature and frame rate status are displayed in the Camera View.
Show display FPS	When checked, and **Show status** is also checked, the frame rate display will also show the display rate in square brackets. This information can help to diagnose the performance of the PC's video subsystem.
Show recording statistics	When checked, when WeldStudio is recording video the Media Tool Window will display the percentage of the incoming frames which the PC

	was able to record.
Temperature unit	Celsius or Fahrenheit degrees can be selected.
Video Recording	
Copyright owner	Allows the user to set the text of the copyright message, if desired
Timestamp	Controls the timestamp which can be optionally written into each frame of the video, see section 4.3.4.1.
Incremental	The recorded timestamp will be the elapsed time since the start of the recording, in hours (24 hr clock), minutes, seconds and milliseconds.
Absolute Date/Time	The recorded timestamp will be the actual time that the video frame was captured, in the format year-month-day hour:minute:second.millisecond.
Include Frame Number	When checked, the frame number *within the video* will be included at the beginning of the timestamp.

4.3.6. Measure Tool

The Measure Tool is used for extracting relative approximate measurements from the image.

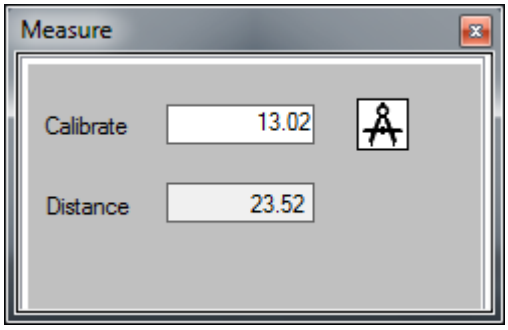


Figure 23: Measure Tool

When this window is activated, a blue line with red end points is shown on the image overlay, as shown in Figure 24.

The tool uses two values, a calibrated distance and an observed distance. A demonstration using a ruler is shown below.

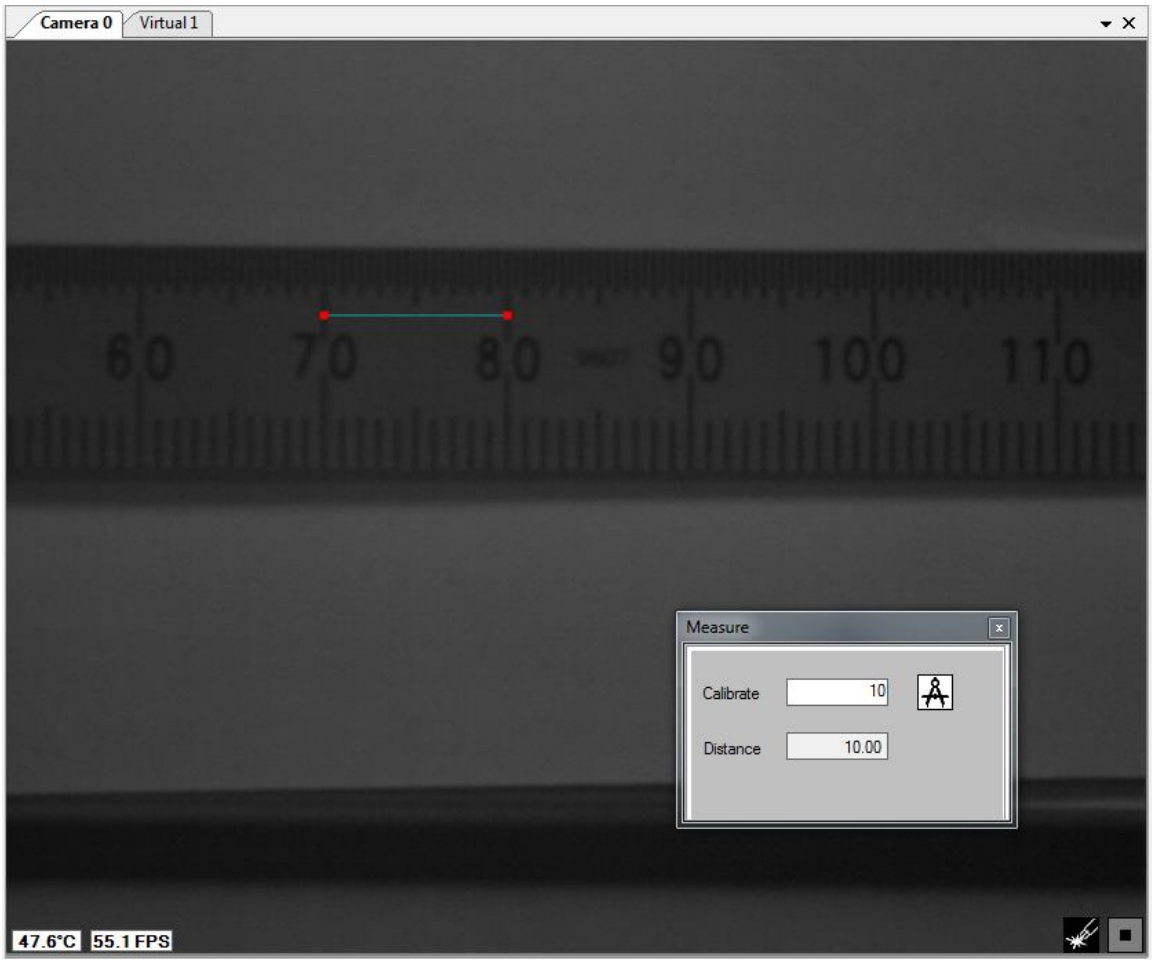


Figure 24: Initial Calibration

To calibrate the tool:

1. Using the mouse, position the ends of the blue line along a feature of known length, in this case 10 mm on the ruler.
2. Enter the correct measurement in the **Calibrate** field,
3. Click the Calibrate button.

4. Observe how the **Distance** field value now matches the **Calibrate** value.

To make a measurement:

1. Move the ends of the blue line to the feature you want to measure, as shown below.
2. The **Distance** field value will update with the measured value as the line is moved.

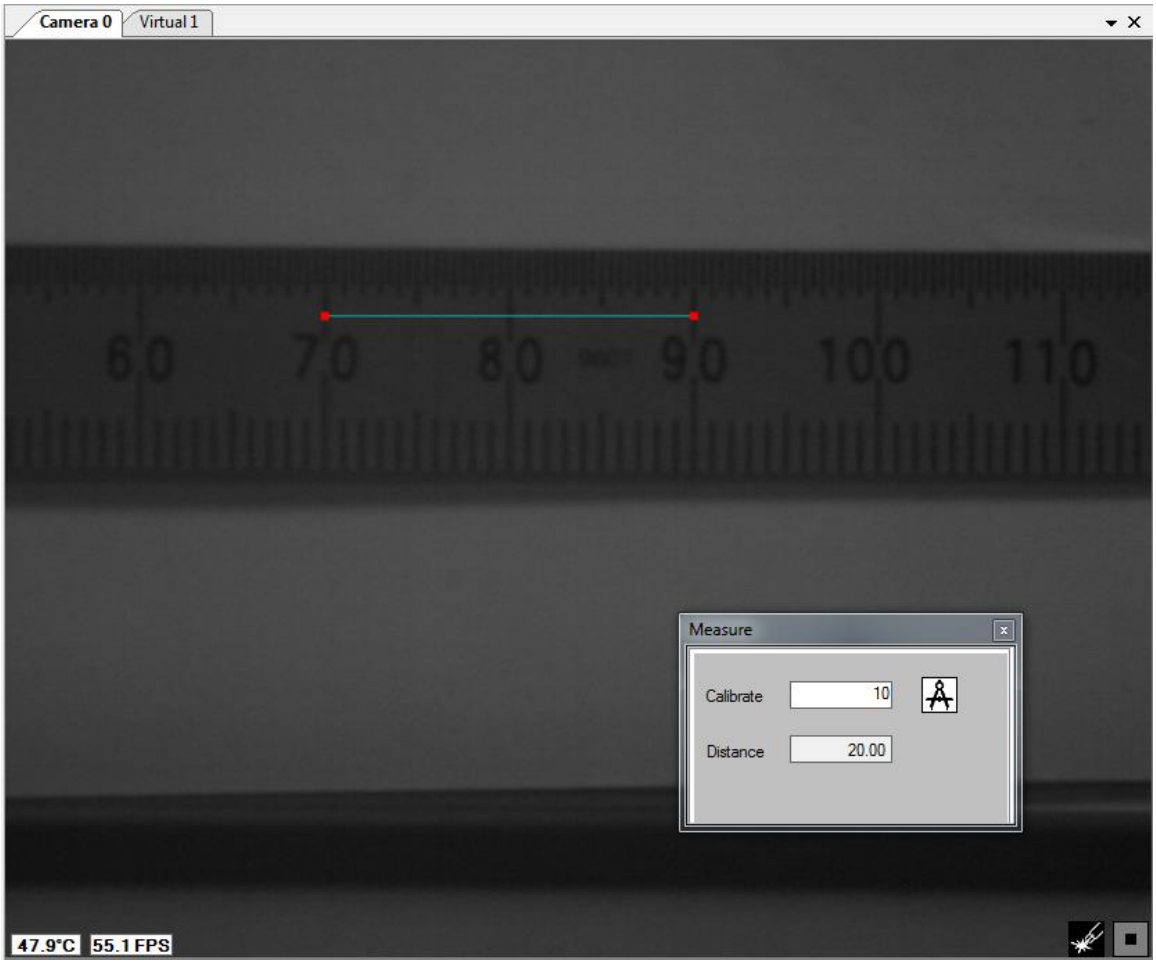


Figure 25: Making a Measurement

4.3.7. Focus Tool

The Focus tool can be used as an aid when focusing the lens. It provides a relative measurement of the sharpness observed in the image.

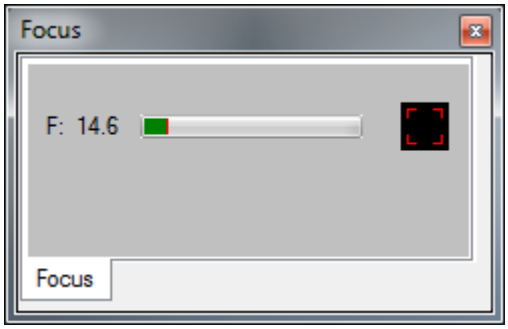


Figure 26 : Focus Tool

Note that the absolute value of focus, shown in bar graph format, is highly dependent on the scene being imaged. As such, there is no “good” value which

can be specified; the information should be used to determine if a particular adjustment to the lens produces a “better” or “worse” focus level.

The measurement can be made either considering the entire image, or from a specified area of interest. This is controlled by the button to the right of the reading.


AOI mode. The AOI can be adjusted using a tool overlay shown on the Camera View.


Full image mode

The green area on the bar graph indicates the current value, the red area on the right indicates the maximum value which has been achieved during this session. This maximum value is reset when changing between AOI and Full Image modes.

4.3.8. Blob Analysis Tool

The Blob Analysis tool provides a demonstration of Xiris’ feature extraction and analysis technology.

The Blob Analysis tool is activated by selecting **Blob Analysis** from the **Tools** menu.

Blobs are arbitrary-shaped groups of connected image pixels. A group of pixels represent a blob if their intensities fall within a user-defined range, and the pixels are connected to each other by touching borders or touching corners. The process of extracting blobs is called segmentation.

Once a blob has been identified, further processing is done to analyze various useful characteristics of the blob, such as its area or perimeter. These properties are shown below.

Property	**Description**
Area	The area of the blob in pixels
CentroidX	The X-component of the blob centroid, or center of mass
CentroidY	The y-component of the blob centroid, or center of mass
Perimeter	The perimeter, in pixels, of the blob
FormFactor	The ratio of the perimeter squared to the area. Ranges from 0.0 to 1.0 such that 1.0 indicates that the blob is a perfect circle
BoundBoxLeft	The location of the left side of the smallest possible bounding box to completely enclose the blob
BoundBoxTop	The location of the top side of the smallest possible bounding box to completely enclose the blob
BoundBoxWidth	The width in pixels from the left side to the right side of the

	smallest bounding box to completely enclose the blob
BoundBoxHeight	The height in pixels from the top side to the bottom side of the smallest bounding box to completely enclose the blob
Orientation	The axis of minimum inertia in engineering degrees (where 0° is due east and numbers increase in the counter-clockwise direction).
Eccentricity	The ratio between the minimum and maximum axes of an ellipse which best fits the blob. A value of 1.0 indicates a perfect circle; a value of 0.0 indicates an ellipse of infinite eccentricity, e.g. a flat line.
EulerNumber	The number of distinct, non-connected particles in the blob minus the number of holes in the blob
Hole Count	The number of holes in the blob
TouchesBorder	A Boolean parameter that is set to 1.0 if the blob touches the border of the Viewport and to 0.0 if it does not
FeretDiameter0	The effective diameter of the blob in the 0° direction (i.e. the distance in pixels from the Box Right edge to the Box Left Edge)
FeretDiameter90	The effective diameter of the blob in the 90° direction (i.e. the distance in pixels from the Box Top edge to the Box Bottom edge)
GrayMass	The sum of the gray level value of all the pixels in the blob
GrayMean	The average gray level value of all the pixels in the blob
Compactness	The Area of a blob divided by the Bounding Box Area

Coordinate System:
Please note that the convention adopted by Xiris is that the X,Y origin is in the top left corner of the screen, with X increasing left to right and Y increasing top to bottom, as such:

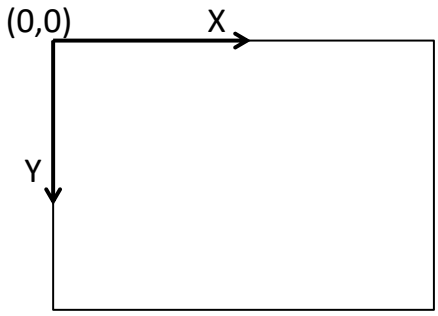


Figure 27 - Coordinate System

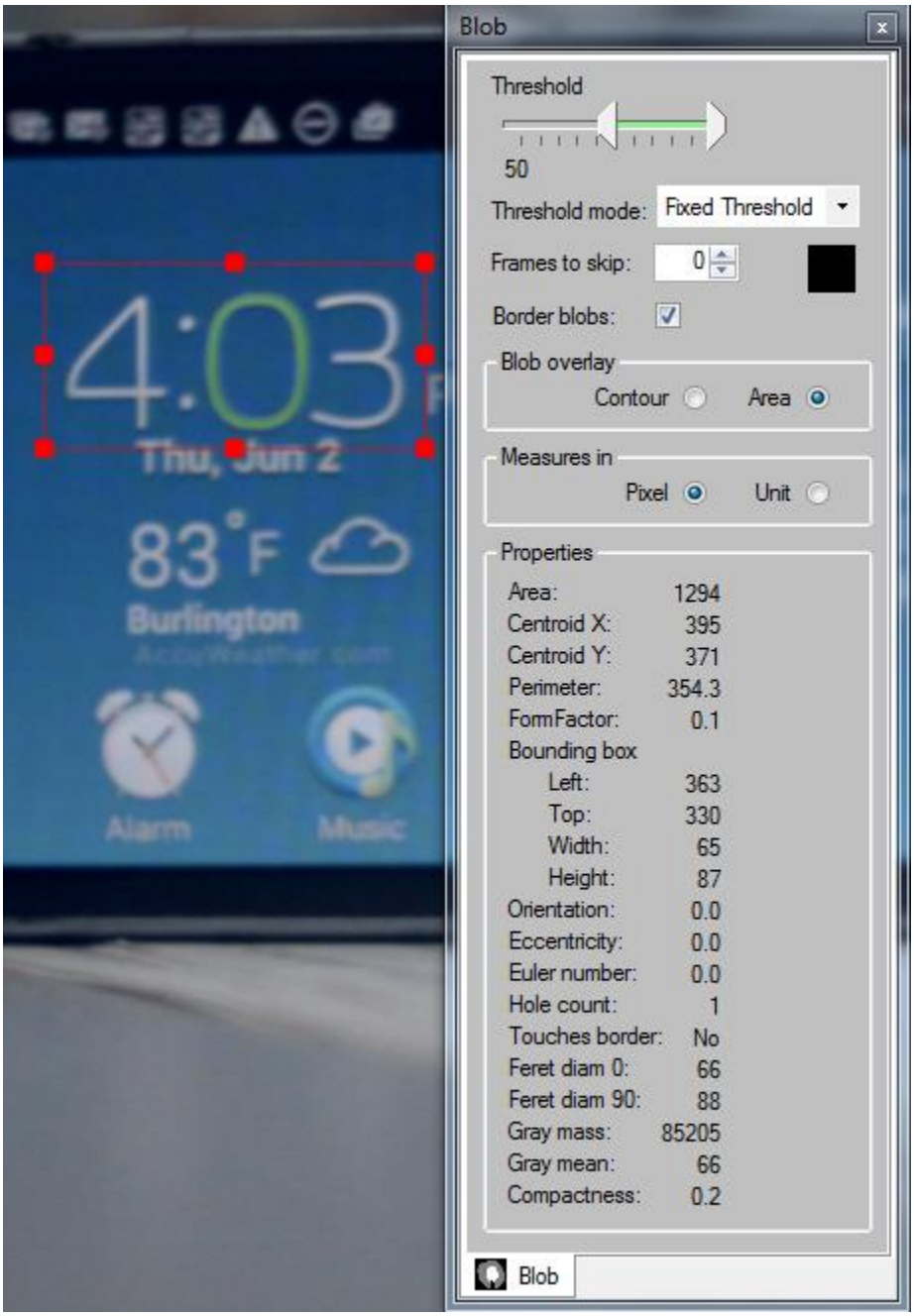


Figure 28 – Blob Analysis Tool and Overlay

The pixel intensity range to be considered is controlled using the Threshold slider. There are two supported modes for pixel selection, controlled by the **Threshold mode** dropdown:

Fixed Threshold	In this case, pixels between the lower and upper slider values are included. Therefore, either dark or bright features may be extracted.
Adaptive	In this case pixels which are above the upper slider value

	are included in a “base” blob, and connected pixels with values between the lower and upper slider values are added to the base blob. Pixels in the lower range are not considered when found in isolation. Therefore, this mode can only be used to extract “bright” features, such as the weld arc and the surrounding puddle.

Similarly to the Focus tool, the Blob Analysis tool can work on the full image or on a user-defined area of interest. The figure above shows the tool in the area of interest mode.


AOI mode. The AOI can be adjusted using a tool overlay shown on the Camera View.


Full image mode

Depending on your situation, you may wish to have the Blob Analysis tool process only 1 of every “n” images. This may be the case when you have limited CPU resources for blob processing but wish to continue to display at a high frame rate. Set the number of **Frames to skip** to 1 to process every-other frame, etc.

In some cases, the largest blob may be one which touches the edge of the image, and this may not be the blob which you wish to analyze. Detection of such blobs can be defeated by un-checking the **Border Blobs** check box.

The detected blob is either outlined of filled in green on the displayed image. This is controlled by selecting either **Contour** or **Area** for the **Blob overlay**, as shown above. Note that in the case where there is more than one blob present, the image overlay and the data reported applies to the blob with the largest area.

The reported data can be viewed in pixels or in the units as defined by the Measure Tool (see above) by selecting **Pixel** or **Unit**, respectively.

4.3.9. Edge Detector Tool

The Edge Detector tool provides a demonstration of Xiris’ edge detection and analysis technology.

The Edge Detector tool is activated by selecting **Edge Detector** from the **Tools** menu.

Edge information is obtained from a *profile*, which is essentially the summation of the pixel values in each column with the tool. Areas of the projection with high

slopes are defined as edges. The slope of the profile indicates the strength of the edge.

Detected edges are shown in the image as light blue overlaid lines.

The **Edge** dialog controls the performance of the Edge Detector, and reports the result for the “best” detected edge.

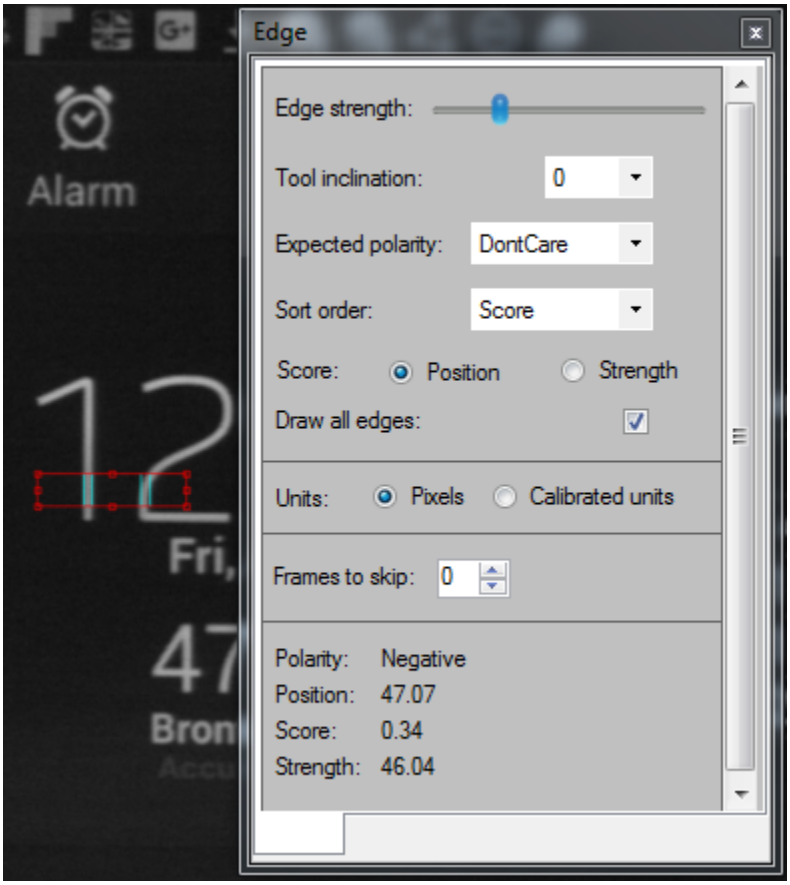


Figure 29 : Edge Detector window

Edges extracted from the profile which meet a minimum strength criteria are considered for further processing. The minimum strength can be adjusted using the **Edge strength** slider. Note that in the example image shown above, the edges are very strong. In normal operation the slider will need to be moved farther to the left in order to detect any edges.

The demonstration tool can detect either vertical edges (as shown) using a **Tool inclination** of 0 degrees, or horizontal edges using a value of 90 degrees.

Edges which move from dark to bright are referred to as being positive, and from bright to dark as being negative. The tool can be configured using the **Expected polarity** setting to detect only positive, only negative, or all edges.

All candidate edges are given a score value from 0 to 1 based on either their position or their strength. This can be selected from the **Score** radio buttons. When **Position** is selected, a perfect score of 1.0 is achieved when the edge occurs at the exact middle of the tool.

The list of candidate edges is then sorted based on the **Sort order** setting. This can be Score (highest score first), Position (left-most or top-most position first) or Inverted Position (right-most or bottom-most position first).

The user interface can be configured to show all the detected edges, or only the first edge in the sorted list, by checking the **Draw all edges** check box.

The data regarding the first edge in the list are displayed at the bottom of the window. The units can be either pixels or the calibrated units from the Measure tool.

Note that the Edge Tool demonstration in WeldStudio does not reflect the full capability of the underlying tool:

- The tool inclination can be any angle from 0 to 360 degrees.
- Edges can be scored on weighted combinations of Position and Strength.
- The expected position to achieve a score of 1.0 is not restricted to the center of the tool.

Custom software written using the Xiris WeldSDK can take advantage of these additional capabilities of the tool.

4.3.10. Light Meter Tool

The Light Meter tool provides statistical information about the pixel values, in either the entire image or a selected AOI. The AOI selection mechanism is the same as for the other machine vision tools, see above, and a description is not repeated here.

The **Light Meter** dialog displays the pixel statistics.

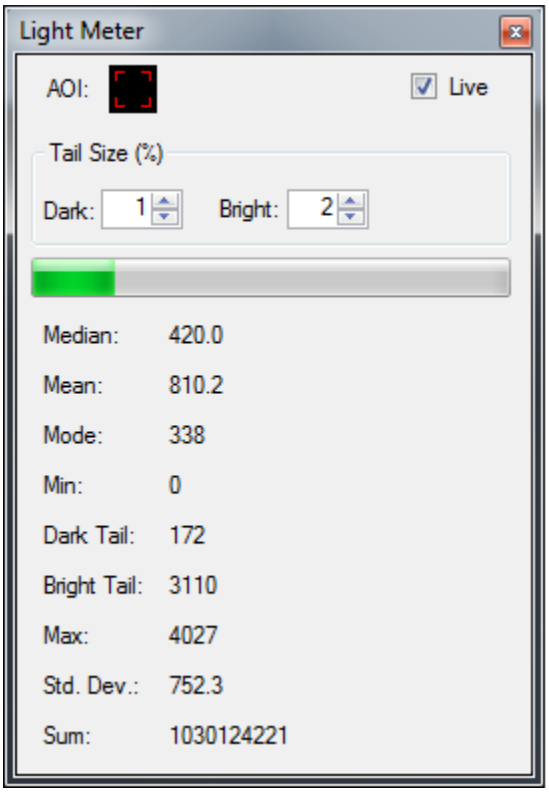


Figure 30 : Light Meter Tool

Most of the statistics are conventional and self-explanatory. The concept of "tails" is further explained below.

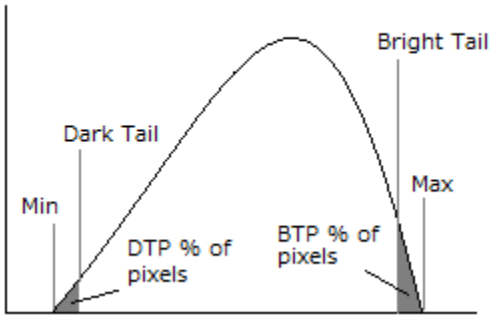


Figure 31: Sample Histogram

The histogram above shows how the Min, Dark Tail, Bright Tail and Max statistics are related.

Min	The value of the darkest pixel.
Dark Tail	The value of the darkest pixel when excluding the Dark Tail Percentage (DTP) of the darkest pixels.
Bright Tail	The value of the brightest pixel when excluding the Bright Tail Percentage (BTP) of the brightest pixels.

Max	The value of the brightest pixel

4.3.11. Digital I/O Tool

The Digital I/O tool is used to monitor the state of the camera's digital inputs and control the state of the digital outputs.

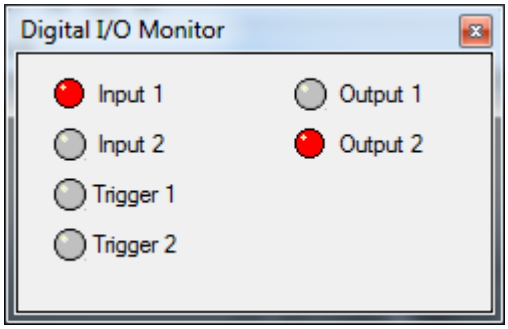


Figure 32 : Digital I/O Monitor

Note that WeldStudio does not use the digital outputs at this time.

Input 1 can be used to control video recording. Input 2 can be used to control raw image recording. Trigger 1 can be used to synchronize video frames with external events, such as pulsed welding. Trigger 2 can be used to change between Setup and Weld mode.

4.4. Connection Diagnostics

The Connection Diagnostics window shows an overview of the camera discovery process.

It can be accessed in one of two ways:

- From the Help → Connection Diagnostics menu item
- By holding down the Shift key when starting WeldStudio

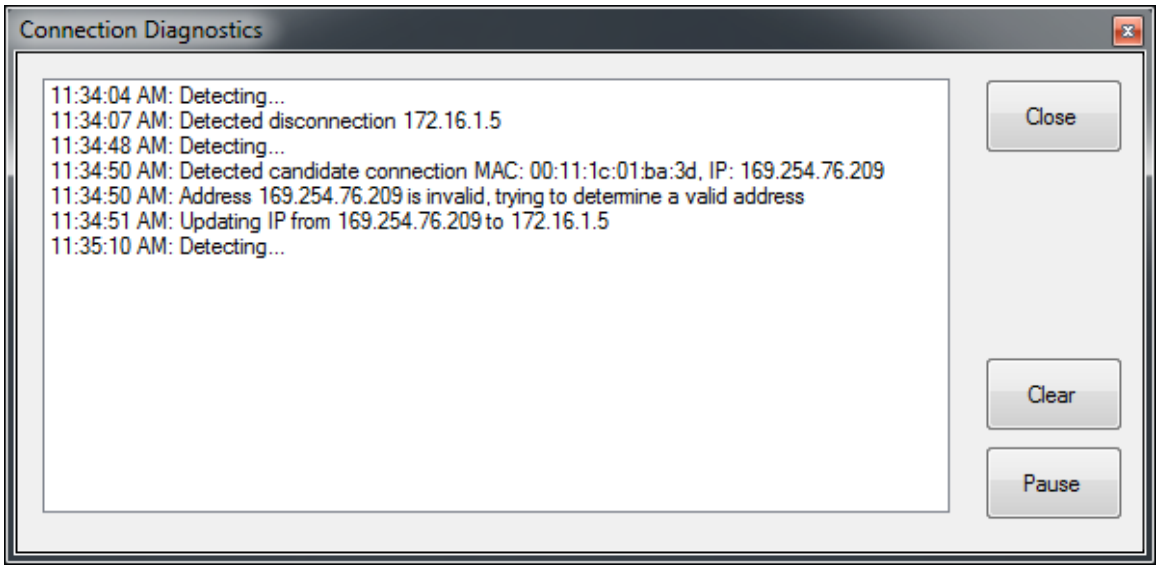


Figure 33: Connection Diagnostics Window

5. Virtual Cameras

A Virtual Camera is a software-emulated camera which provides images to the WeldStudio software as if a real camera were attached. The images are loaded from previously recorded raw image files, see section 4.3.4 above. Virtual cameras can be used in several scenarios, such as to generate demonstrations, or to analyze the impact of processing.

To create a virtual camera, select the **Window → Create Virtual Camera** menu item. A new Camera View window will be created, as shown below.

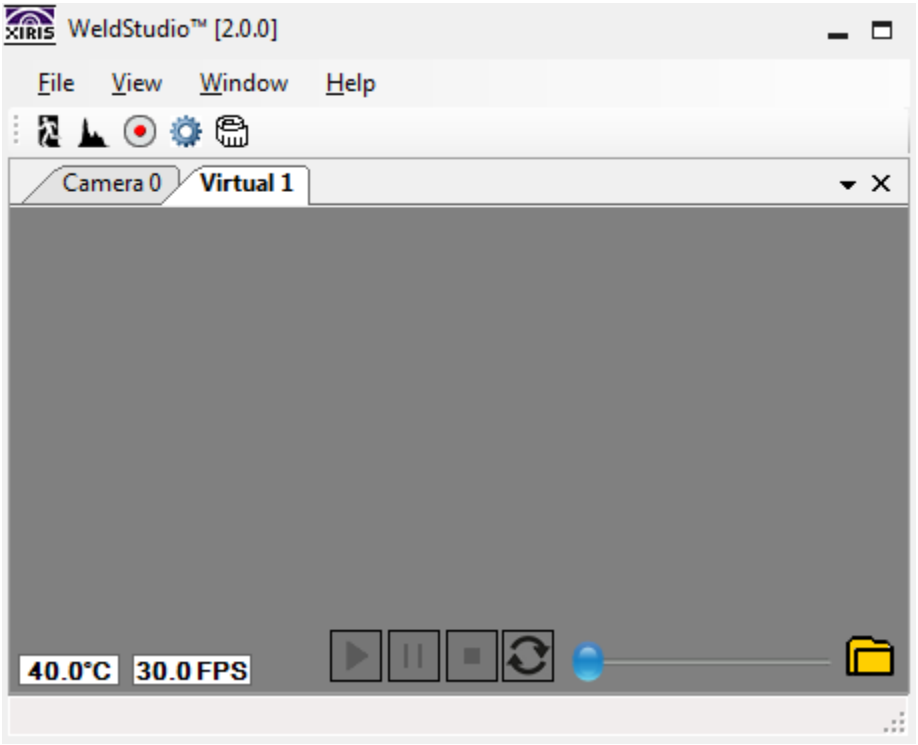


Figure 34: Camera View with Virtual Camera

To select the images to be used, click on the folder icon at the bottom right corner, and select a folder which contains raw image files.

To control the camera “streaming”, use the player control buttons:

	Start playing the images.
	Pause the stream. While paused, the slider can be used to move through the image sequence.
	Stop the stream and reset to the beginning of the images.

	Enable or disable endless-loop mode.

6. Recording Control via Digital I/O

The recording functions of WeldStudio can be controlled via the user interface, as described above, or using the digital input lines. Consult the Camera Operator's Manual for information on the electrical interface to the digital inputs.

The GPIO_IN1 signal controls video recording. A transition from low to high will initiate recording, and the opposite transition will stop recording.

Note that there is a short (1-2 second) but indeterminate time window after starting video recording before a falling edge will cause recording to stop (the transition will be detected, but just not have immediate effect). This ensures that all video files have unique file names.

After ending a video recording there is a similar time window during which a rising edge will not have immediate effect. During this time all outstanding frames are finalized and the video file is moved to the specified destination folder.

The GPIO_IN2 signal controls the saving of raw images. A transition from low to high will start the process, and the opposite transition will stop the process.

Any "command" via the GPIO_IN signals can also be controlled via the corresponding elements in the GUI, with no priority assignment between the two. For example, if recording is started via GPIO_IN1, it can be stopped from the GUI, and the next falling edge on GPIO_IN1 will have no effect.

7. XVideoPlayer Overview

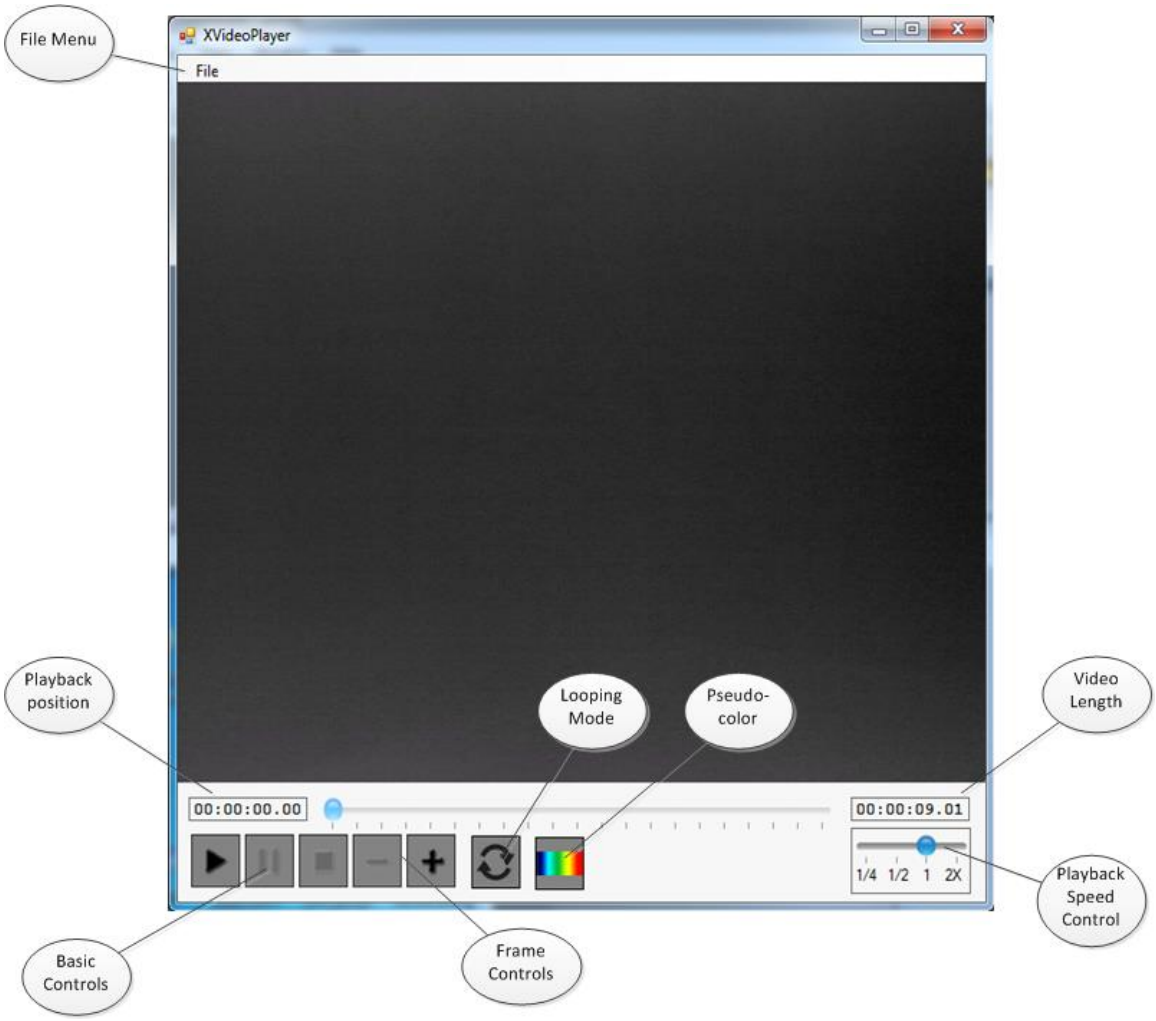


Figure 35: XVideoPlayer Overview

8. Add-Ins Overview

Add-ins are custom software components which can be used to add data overlays to the displayed and/or recorded video. They are primarily used to interface to other hardware and overlay data from that device on the video.

Contact your sales representative for more information on Add-Ins.

Add-ins are managed via the **Tool → Add-Ins** menu item. Each available add-in can be enabled or disabled, and can be configured to display its information on the live video display (and hence also in any recorded video) or for the content to be added to recorded video only.

The Add-Ins configuration window also allows for acces to any configuration user interface which the add-in may implement.

Figure 36 : Add-Ins Configuration

Appendix A: Raw Image File Format

A raw image file consists of a header section and a data section.

The schema of the header can be deduced from the first two bytes of the file:

First Bytes	Schema
0,0	1
Otherwise	0

Schema 0 Header

The header section consists of 8 bytes organized as four 16-bit words (standard little-endian/Windows format):

Bytes	Data	Comments	
0:1	IMG_HEIGHT	The image width in pixels	
2:3	IMG_WIDTH	The image height in pixels	
4:5	BITS_PP	The number of bits per pixel (8 or 12)	
6:7	PIXEL_FMT	0	Monochrome, 8 bits per pixel
		1	Monochrome, 12 bits per pixel
		2+	Reserved for future use

The data section contains IMG_HEIGHT * IMG_WIDTH * BITS_PP / 8 bytes of pixel data.

Schema 1Header

The header section consists of 288 bytes organized as nine 32-bit words (standard little-endian/Windows format):

Word	Data	Comments
0	SCHEMA	0
1	HEADER_LEN	The size of the header in words (i.e. 9)
2	AOI_LEFT	The horizontal start position of the Area of Interest in effect.[6]
3	AOI_TOP	The top line of the Area of Interest.
4	AOI_RIGHT	One more than horizontal end position of the Area of Interest in effect (e.g. 1280 for a full-width AOI).
5	AOI_BOTTOM	One more than the bottom line of the Area of Interest (e.g. 1024 for a full-height AOI)

[6] Because of the nature of the XVC-1000 camera, the horizontal aspect of the AOI function is implemented in software, after the point at which raw images are saved. To reproduce the image "as processed", the user must implement the horizontal aspect of the AOI function in the software reading the file.

6	IMG_WIDTH	The full image width in pixels, i.e. the line stride.	
7	BITS_PP	The number of bits per pixel (8 or 12)	
8	PIXEL_FMT	0	Monochrome, 8 bits per pixel
		1	Monochrome, 12 bits per pixel
		2+	Reserved for future use

The data section contains (AOI_BOTTOM – AOI_TOP) * IMG_WIDTH * BITS_PP / 8 bytes of pixel data.

Data Section

The first byte(s) represent the pixel at the top-left corner of the image, and the image pixels can be read out in row-major order, i.e. [x,y] = [0,0] [1,0] [2,0] … [IMG_WIDTH-1,0] [0,1] [1,1] [2,1] … [IMG_WIDTH-1,IMG_HEIGHT-1].

When PIXEL_FMT is 0 (monochrome 8 bits), each byte represents one pixel.

When PIXEL_FMT is 1 (monochrome 12 bits), each three bytes represent two pixels.

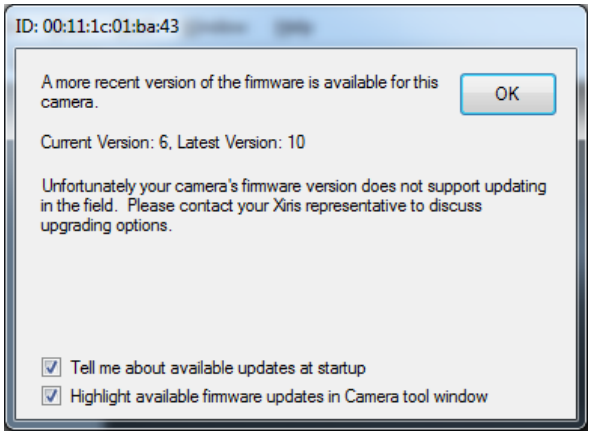
- the first byte contains the top 8 bits of the first pixel
- the second byte contains the bottom 4 bits of the first pixel in the low nibble and the bottom 4 bits of the second pixel in the high nibble
- the third byte contains the top 8 bits of the second pixel, etc.

Appendix B: Firmware Update

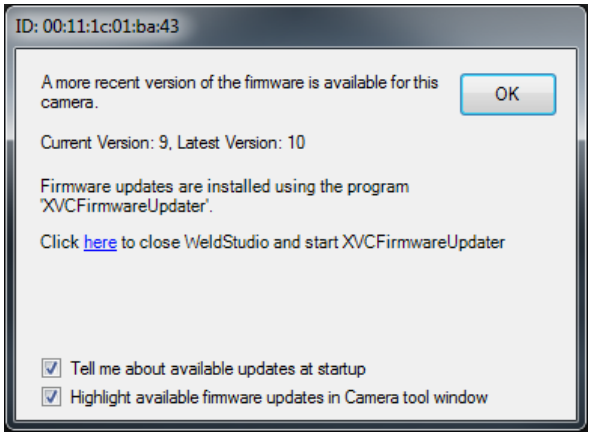
	Note that the information in this Appendix only applies to cameras currently running version 7 of the firmware or later. Older cameras must be returned to the factory for upgrade.

When new firmware is available, an update can be started automatically when WeldStudio starts, or manually via the Camera Tool window by clicking on the notice:

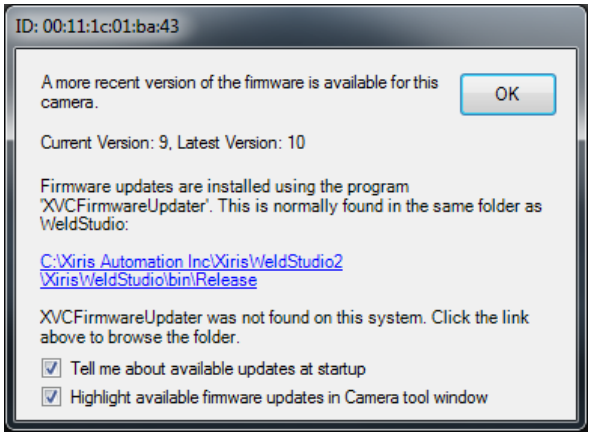
If your camera does not support firmware update, you will see a window similar to the following:



Otherwise, you will see the a window similar to the following. This window allows you to modify when notifications of new firmware are shown, as well as a link to access the XVCFirmwareUpdater program.



The XVCFirmwareUpdater program is normally installed in the same folder as Xiris WeldStudio. If for some reason this is not the case, the message will be slightly different:

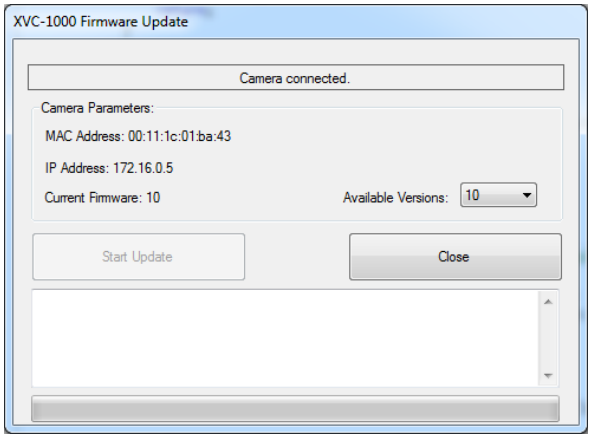


In all cases, to update the firmware you will eventually run the XVCFirmwareUpdater program.

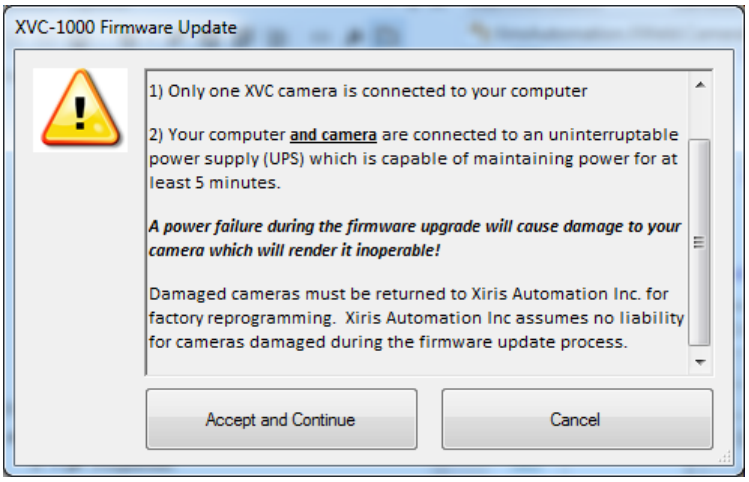
	Since only one piece of software may access the camera at a time, WeldStudio must be closed for XVCFirmwareUpdater to detect the camera. When possible this will be done automatically for you, and WeldStudio will be automatically restarted after the update is complete.

Firmware Update

The main window appears as follows:



To update (or downgrade, if desired and available) the firmware, select the desired version from the **Available Versions** list, and then click **Start Update**.



After reviewing the entire warning message, click **Accept and Continue** and the update will start. The update will take a few minutes.

STOP	A power failure during firmware update may cause the camera to become inoperable. Ensure that both your PC and the camera are powered by an uninterruptable power supply (UPS).

⚠	After updating the firmware, the camera will continue to report the previous version number until it is re-booted by cycling the power. Nonetheless, the new firmware will be running.

Configuring Notifications

The two check-boxes can be used to control how WeldStudio reacts when there is a firmware update available.

☑ Tell me about available updates at startup Un-check this box to disable the notification which occurs at startup, as shown in Figure 2.
☑ Highlight available firmware updates in Camera tool window When checked, the new firmware notice will be red if there is an update available. When un-checked, the notice will always be black.

Revision History			
Rev	**Date**	**Reason for revision**	**Revised by**
0	2014/12/17	Initial Release (Version 2.0.0)	DZ
1	2015/1/20	Reflect version 2.0.1 software	JS
2	2015/4/6	Reflect version 2.0.3 software	JS
3	2015/7/15	Reflect version 2.0.6 software and XVC-1000e support	JS
4	2015/12/10	Reflect version 2.0.7 software	JS
5	2016/01/29	Reflect version 2.0.8 software	JS
6	2016/04/01	Reflect version 2.0.9 software	JS
7	2016/06/01	Reflect version 2.1.0 software	JS

Document Approval		
Phase	**Date**	**Signature**
1: Author		
2: Manager		